Sea Based Joint Precision Approach and Landing System (JPALS) System Requirements Document

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REVISIONS

Revision Number	Date	Description	Pages Affected
-	30 Oct 03	Initial Release	All
A	25 Jun 04	Complete update based on harmonizing outline with Land Based JPALS documents, ORD-SRD trace, and ongoing engineering efforts.	All

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1 Scope

1.1 Identification

This System Requirements Document (SRD) contains system level requirements for the Sea Based Joint Precision Approach and Landing System (JPALS).

Requirements contained within this document were derived to support the *Operational Requirements Document (ORD) for the Joint Precision Approach and Landing System (JPALS)* (USAF 002-94-I), Block I Shipboard Operating Environment (SOE) [10].

Note: This specification was developed to support the ORD referenced above. The ORD will be replaced by a Capability Development Document (CDD) and future versions of the Sea Based JPALS specifications will be updated to show traceability to the CDD.

1.2 System Overview

JPALS provides the Department of Defense (DoD) with a navigation, air traffic control, and landing capability for Shipboard operations and a terminal navigation, precision approach, and landing capability for Fixed Base, Tactical, and Special Mission operations ashore. JPALS consists of modular avionics and ground components to provide a range of navigation, air traffic control, and landing capabilities that can be tailored to satisfy mission needs. JPALS information will be broadcast from ground or ship systems to aircraft avionics. The JPALS Operational View-1 (OV-1) is shown in Figure 1-1.

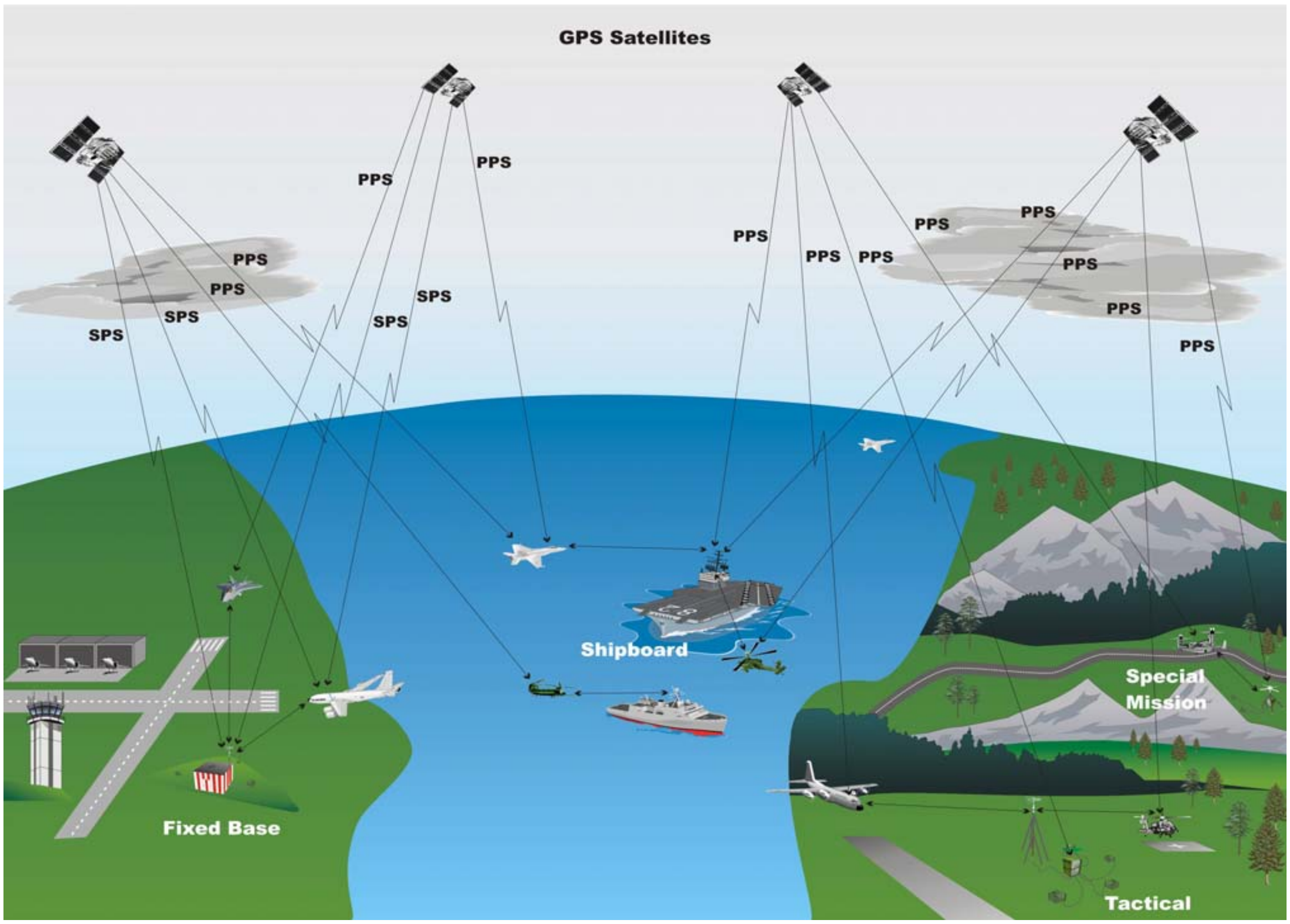

Figure 1-1: JPALS OV-1

Sea Based JPALS supports three-dimensional positioning and guidance, secure two-way communications with the ship, separation of aircraft on approach, and monitoring of approach data by ship operators on

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military air-capable ships. Sea Based JPALS is a safety-critical system consisting of hardware and software that uses the Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System (GPS) Precise Positioning Service (PPS) and a data link (DL) network to perform relative navigation to JPALS-equipped US Navy and North Atlantic Treaty Organization (NATO) ships. Relative measurement processing using GPS data is used to meet the accuracy, integrity, continuity, and availability requirements of Sea Based JPALS supported operations. The ship relative augmentations to GPS PPS are based on relative GPS positioning concepts. GPS measurement functions within Sea Based JPALS are protected by GPS anti-jam equipment. The DL network supports the relative navigation functions and is intended to aid in monitoring functions and to supplement ship-to-air and air-to-ship communications.

1.3 Operating Environment

Sea Based JPALS must be capable of operating while at sea under potentially severe marine weather and ship motion conditions and in a challenging electromagnetic environment. Hostile enemy action will normally be targeted on the aviation ship and will typically include long-range missiles and subsurface threats. Information generated by Sea Based JPALS must be protected against enemy efforts to detect, classify, geo-locate, and/or target friendly forces (e.g., the aircraft carrier). Flight operations are conducted on multiple classes and types of ships that may be deployed individually or within a battle group or task force. The role and use of Sea Based JPALS in support of operations in this environment are described in detail in the *Concept of Operations (CONOPS) for Future Air Traffic Control Operations using the Sea Based Joint Precision Approach and Landing System (JPALS)* (CONOPS) [3].

1.4 JPALS Requirements Hierarchy

This SRD is part of a family of documents that establish the system, performance, and interface requirements for Sea Based JPALS. Figure 1-2 illustrates the hierarchy of the various Sea Based JPALS requirements documents.

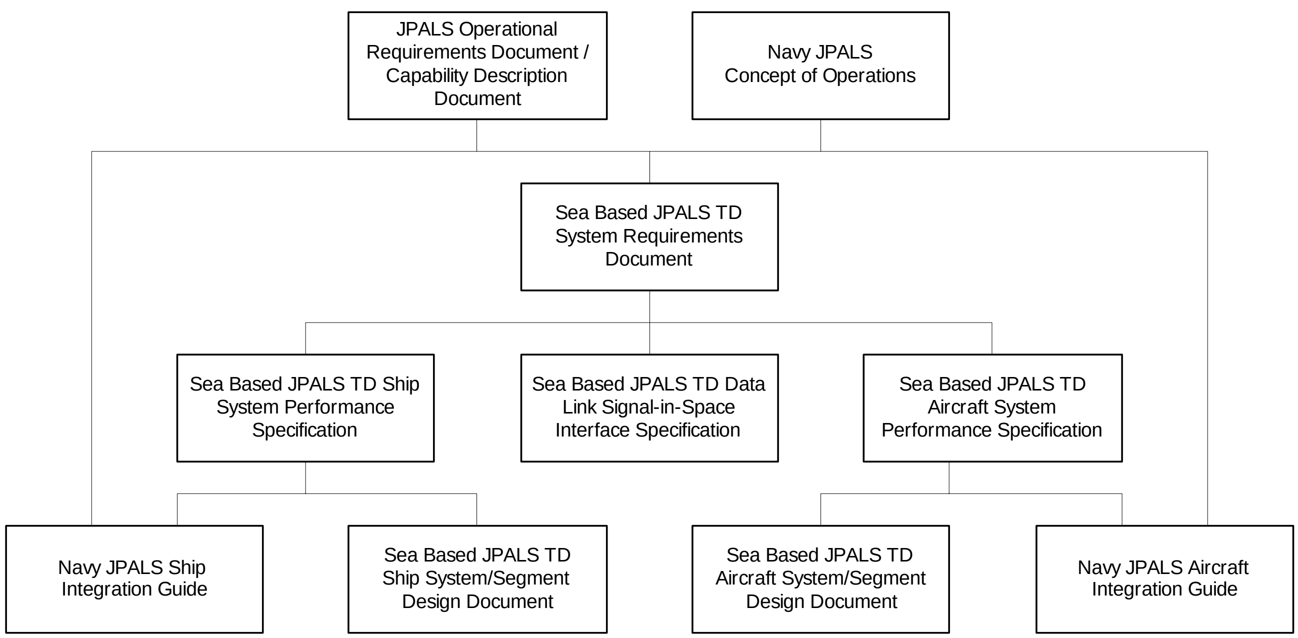

Figure 1-2: Sea Based JPALS Specification Tree

The JPALS ORD [10] contains the JPALS operational requirements, which are the primary source for the Sea Based JPALS performance requirements. Additional Sea Based JPALS performance requirements were derived to support the capabilities and operations described in the CONOPS [3]. The system level requirements derived from the JPALS ORD [10] and CONOPS [3] are documented in this SRD. From the SRD, performance requirements are then allocated to the Sea Based JPALS-Ship specification and the Sea Based JPALS-Air specification, as applicable. The interface between ship and air is defined in the Sea Based JPALS DL Signal-in-Space (SIS) Interface specification

Both the Sea Based JPALS-Ship and Sea Based JPALS-Air specifications have companion integration guidance documentation. The integration guidance documents will provide detailed information pertaining to the installation and integration of Sea Based JPALS on ships and aircraft.

Design documents will be created during the Technology Development (TD) phase of the JPALS program to reflect the Sea Based JPALS-Ship and Sea Based JPALS-Air design used to validate these requirements and allocation decisions made during that phase.

1.5 Document Overview

This document contains the following sections:

1. Scope: Contains the project identification, system and document overviews, and a list of assumptions used in this document.

2. Reference Documents: Provides a list of the documents referenced in this standard. References contain the document number, exact title, revision level, and issue date.

3. Requirements: Specifies the requirements for the system to which this specification applies.

4. Quality Assurance and Verification Requirements: Details how the requirements of Section 3 are verified.

5. Terms and Acronyms: Defines terms and acronyms used in this document.

6. Interface Data Definition: Provides definition of the data elements passed across the interfaces defined this document.

7. Jamming Condition Definition: Defines the jamming environment referred to in Section 3.

The word "equipment", as used in this document, includes all components (hardware and software) or units necessary (as determined by the equipment manufacturer or installer) to properly perform its intended function.

In this document, the term “shall” is used to indicate requirements. An approved design would comply with every requirement, which can be assured by inspection, test, analysis, or demonstration.

The terms “must” and “will” are used to identify items which are important but are either duplicated somewhere else in the document as a “shall”, or are specified in other documents. However, they are not requirements to be verified.

The term “should” is used to denote a recommendation that would improve the Sea Based JPALS but does not constitute a minimum requirement.

The term "objective" is used indicate objectives or recommended requirements as identified in the JPALS ORD [10]. These objectives are separately listed below the threshold requirements to which they are related.

1.6 Assumptions

1.6.1 Environment

It is assumed that the environment specified in section 3.2.5 in which Sea Based JPALS must operate bounds the actual operational environment. If the environment is more severe than that specified in Section 3.2.5, the availability of Sea Based JPALS may be reduced; however, requirements related to safety of flight will still be met.

1.6.2 GPS Signal-In-Space

It is assumed that GPS satellites transmit signals that comply with ICD-GPS-200C [5] and the *Global Positioning System Standard Positioning Service (SPS) Performance Standard* [4].

Note: The GPS PPS Performance Standard will be applicable and referenced when published.

JPALS performance assumes all GPS satellites in view support dual frequency code and carrier phase measurements all the time.

1.6.3 Sea Based JPALS Application

Sea Based JPALS technology is fundamentally different from current navigation and Air Traffic Control (ATC) systems such as SPN-41, SPN-46, air surveillance radar, and TACAN. Therefore, Sea Based JPALS will incorporate new and different procedures for operations around Navy ships. In general, these differences will be in specific operator actions rather than generic functions supporting navigation, communication, and separation. Although some procedures will differ, it is possible to integrate them with current operations such that JPALS-equipped and legacy aircraft can operate in a compatible manner. In other words, Sea Based JPALS will be used to support the same ATC functions as legacy systems, allowing Sea Based JPALS to be incorporated into the fleet while a large number of aircraft still use legacy systems. As the air wing approaches full JPALS equipage, it is anticipated that Sea Based JPALS procedures will be revised or extended to take greater advantage of the system's performance capabilities.

2 Reference Documents

The documents listed in this section are cited in this specification. This section also includes documents recommended for additional information or as examples. The following documents form a part of this specification to the extent specified herein.

[1] 29 CFR 1910, Code of Federal Regulations. Title 29 Labor, Part 1910 Occupational Safety and Health Standards, Subpart Z Toxic and Hazardous Substances, 1 July 2003, Department of Labor.

[2] CJCSI 6130.01C, *2003 Chairman of the Joint Chiefs of Staff (CJCS) Master Positioning, Navigation, and Timing Plan*, 31 March 2003, Joint Staff, Washington, DC.

[3] *Concept of Operations (CONOPS) for Future Air Traffic Control Operations using the Sea Based Joint Precision Approach and Landing System (JPALS) IOC (2012)*, Draft, 15 May 2004, Naval Air Warfare Center.

[4] *Global Positioning System Standard Positioning Service Performance Standard*, (no number), October 2001, Department of Defense.

[5] ICD-GPS-200C, *NAVSTAR GPS Space Segment/Navigation User Interfaces,* IRN-200C-005R1, 14 January 2003, ARINC Research Corporation, 2250 E. Imperial Highway, Suite 450, El Segundo, CA 90245-3509.

[6] *Joint Technical Architecture (JTA) Version 6.0*, 3 October 2003, Department of Defense.

[7] MIL-HDBK-454, *General Guidelines for Electronic Equipment,* 28 April 1995, Department of Defense.

[8] MIL-HDBK-2036, *Preparation of Electronic Equipment Specifications*, 1 November 1999, Department of Defense.

[9] MIL-STD-1472F, *Human Engineering Design Criteria for Military Systems Equipment and Facilities,* 23 August 1999, Department of Defense.

[10] *Operational Requirements Document (ORD) for Joint Precision Approach and Landing System (JPALS)*, USAF-002-94-I, 19 March 2003, Air Force Flight Standards Agency.

[11] *Shipboard Integration Trade Study Report (Shipboard Integration Guide) for the Sea Based Joint Precision Approach and Landing System (JPALS)*, 7 May 2004, Sierra Nevada Corporation.

[12] SRGPS-AIGD-0016, *Joint Precision Approach and Landing System (JPALS) Aircraft Integration Guidance Document,* Version 1.0, 25 March 2004, Naval Air Systems Command.

[13] SRGPS-SIS-0006-A, *Sea Based JPALS Data Link Signal-in-Space Interface Specification*, Version 1.5, 25 June 2004, ARINC Engineering Services, LLC.

2.1 Order of Precedence

In case of a conflict between this document and the referenced documents, the order of precedence in descending order is as listed below unless otherwise noted herein.

1. Applicable Federal, State, or Local Laws and Regulations
2. JPALS ORD
3. Sea Based JPALS SRD (this document)
4. Other referenced specifications and documents referenced in section 2.

In case of conflict between referenced documents at a lower order of precedence than this document, the more restrictive requirement applies, unless otherwise approved by the Government in the form of a change to this document or by contractually effective means.

Lack of a requirement at a higher level of precedence is not considered a conflict. The more detailed requirement applies.

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3 Requirements

3.1 System Definition

3.1.1 Major Functional Capabilities

Sea Based JPALS, as an integrated system, comprises four main functions supported by additional aircraft and shipboard functions as shown in Figure 3-1 and defined in the paragraphs below. The function descriptions in the following paragraphs are not intended to require a particular architecture. A number of different architectures may be suitable to meet the functional and performance requirements specified herein.

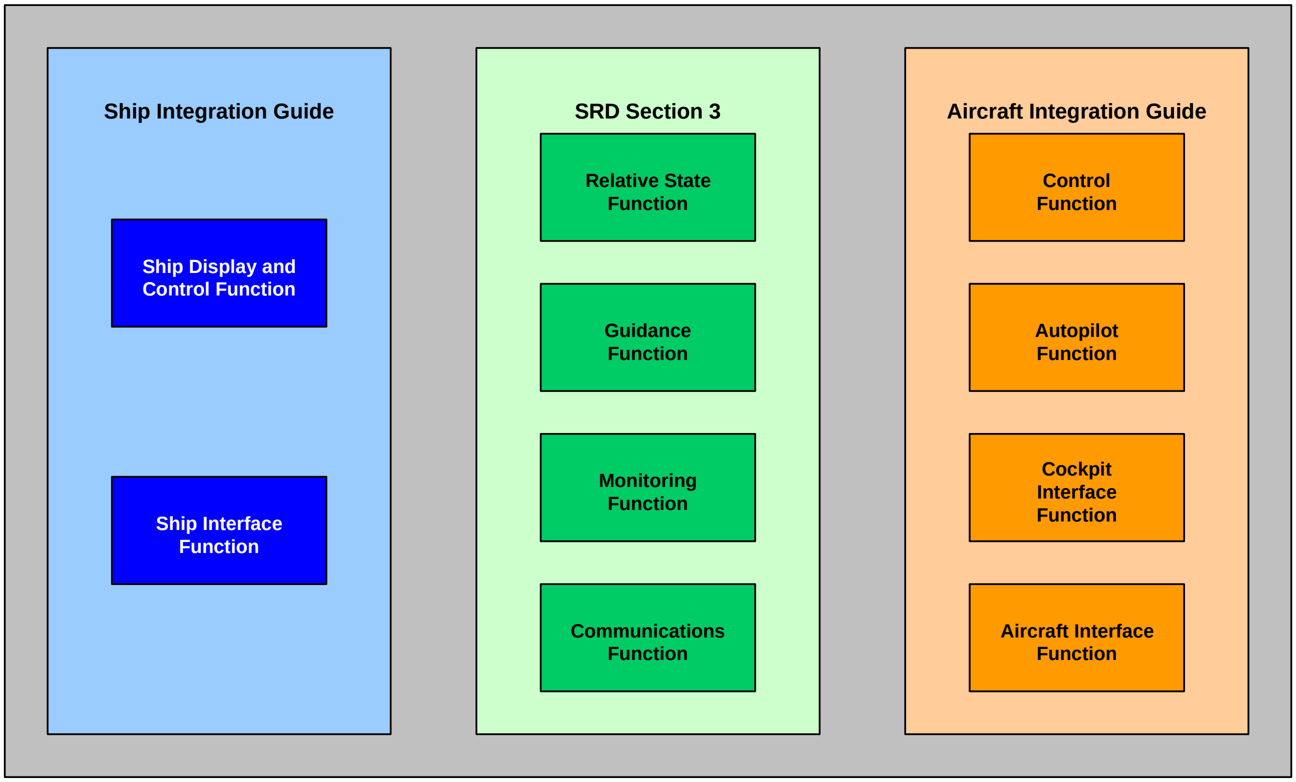

Figure 3-1: Sea Based JPALS Functions

3.1.1.1 Sea Based JPALS Main Functions

3.1.1.1.1 Relative State Function

The relative state function determines the relative position states of an aircraft with respect to its assigned ship. It provides the position states to a specified level of integrity, continuity, and availability. The system includes both a basic and precision relative state function.

The basic relative state function calculates relative position and velocity of the aircraft with respect to the ship to support area relative navigation operations such as marshal, departure, bolter pattern, missed approach, and non-precision approach (NPA). Using the relative position information, the relative state function derives and outputs range and bearing to the ship to support area relative navigation. During area relative navigation, barometric altimeter is normally used for vertical navigation (even though the relative state function will normally be able to output a vertical position).

The precision relative state function operates when receiving precision GPS data from the ship. It calculates precise relative position, velocity, and acceleration to support approach, landing, taxi, bolter, waveoff, missed approach, launch, and departure.

3.1.1.1.2 Guidance Function

The guidance function computes all of the necessary guidance data required for area relative navigation and Case I, II, and III departures and recoveries, from marshal to approach, landing, waveoff, bolter, takeoff, and departure.

The guidance function computes the path that the aircraft should follow and then determines the deviation states of the aircraft and the range and range rate along the commanded path.

For precision operations, the guidance function stabilizes the path and the relative position states of the aircraft to account for the motion of the ship. The path and position states are stabilized to a center of motion point on the ship. This is accomplished by sensing the movements of the ship in all six degrees of freedom (heave, surge, sway, pitch, roll, and yaw). The guidance function also generates deck motion compensation (DMC) data that may be used by the control function.

3.1.1.1.3 Monitoring Function

The monitoring function provides sufficient data exchange between an aircraft and the ship to provide shipboard operators with situational awareness of all aircraft in the network. The monitoring function includes basic and precision capabilities.

Basic monitoring provides shipboard controllers (departure, marshal, approach) with sufficient data to perform sequencing and separation functions based on Sea Based JPALS. The basic monitoring data is also provided to other aircraft in the vicinity. Those aircraft can use this data to update their traffic information displays to aid in separation and collision avoidance.

The precision monitoring function provides data for the final controller and Landing Signal Officer (LSO) to monitor approach performance. In addition, it includes detailed path error, aircraft state data, and other aircraft parameters to support the LSO.

3.1.1.1.4 Communications Function

The communications function allows for exchange of ATC data and commands between the pilot or unmanned vehicle, and the shipboard operators. It also provides for the exchange of aircraft reports during Naval Air Training and Operating Procedures Standardization (NATOPS) operations and uplink of ships "99" information. It includes other configuration, initialization, and miscellaneous data exchange. Additionally, this function provides for pre-launch and post recovery data transmission and reception.

3.1.1.2 Aircraft Functions

A general description of aircraft functions along with system-level requirements and interfaces are provided in this document. As the implementation of these functions is aircraft dependent, all specific functional and performance requirements will be provided in the *JPALS Aircraft Integration Guidance Document* [12].

3.1.1.2.1 Control Function

The control function computes the appropriate outer loop commands (such as bank, vertical rate, speed, throttle, nose wheel steering) required by the aircraft to keep the path deviation within acceptable limits. The control function computes additional commands designed to enable the aircraft to accurately follow commanded path curvatures and path motions due to the yaw perturbations of the commanded approach centerline.

This function contains the control features required for acceptable takeoff and landings on a ship. This may be implemented using the DMC data computed by the guidance and switching on the DMC commands at the appropriate time. The DMC gains are intended to get the aircraft in phase with the ship motion as the aircraft nears the ship.

The control function also computes outputs to drive flight director displays.

3.1.1.2.2 Autopilot Function

The autopilot function computes the appropriate commands for flight control surfaces and propulsion required to get the aircraft states to follow the outer loop commands from the control function.

The autopilot function will be optimized with the control function to provide satisfactory position deviations in air turbulence. Due to ship airwake disturbances, it is likely that higher autopilot control law gains will be required for shipboard takeoff and landing than is required for up and away or land based operations. The autopilot function will be designed to minimize cross-axis coupling to the point where cross-axis responses during any phase of flight, including DMC, are satisfactory.

3.1.1.2.3 Cockpit Interface Function

The cockpit interface function contains those features necessary to provide aircrew interface through cockpit instruments and other display/command interfaces for the aircraft. This function also includes configuration, startup, and other stored parameters necessary to support aircraft system initialization, alignment, and operation.

This function provides the aircrew with sufficient information in a format that complies with human factors guidelines that allows the aircrew to perform the intended operations. Displays include all indications and flight director (command) symbology for all flight modes. The aircrew has control over aircraft system modes and can receive and respond to system and ATC commands. Annunciations are provided for system warnings and cautions, including integrity and loss of navigation alerts.

3.1.1.2.4 Aircraft Interface Function

Sea Based JPALS will interface to aircraft systems to provide or receive various data. These other aircraft interfaces may include air data systems, mission computers, flight management or vehicle management systems, crypto fill, mission planning data bases, and propulsion systems.

3.1.1.3 Shipboard Functions

A general description of shipboard functions along with system-level requirements and interfaces are provided in this document. As the implementation of these functions is ship dependent, all specific functional and performance requirements will be provided in the *JPALS Shipboard Integration Guide* [11].

3.1.1.3.1 Shipboard Display and Control Function

The shipboard display and control function provides situational awareness data for ATC controllers (marshal, departure, approach, and final), Air Boss, Mini-Boss, and LSO to monitor Sea Based JPALS operations. This function also supports the ability for shipboard operators to input ATC commands and set or select other parameters for transmission to aircraft by Sea Based JPALS. The implementation of this function is ship dependent and will be provided simultaneously at various stations on the ship as applicable.

3.1.1.3.2 Ship Interface Function

Sea Based JPALS will interface with a number of shipboard systems to provide or receive various data. These other shipboard systems may include Aviation Data Management and Control System (ADMACS), the Joint Unmanned Combat Air System (J-UCAS) Mission Control System (MCS), Shipboard Air Traffic Control Communications (SATCC), Moriah Wind System, Integrated Launch and Recovery Television System (ILARTS), Integrated Ship's Information System (ISIS), and Improved Fresnel Lens Optical Landing System (IFLOLS).

3.1.2 States and Modes of Operation

There are no states or modes of operation defined at the system level.

3.1.3 Interface Definition

Figure 3-2 shows a context diagram of the Sea Based JPALS. The diagram defines the relationship between the four main functions of Sea Based JPALS and external interfaces. Sea Based JPALS has additional interface requirements that are not necessarily associated with the four main functions. Specifically, Sea Based JPALS will accept input from other systems for the purposes of establishing or joining an established network and Sea Based JPALS will output system status and alarms for use by operators and other systems. While not represented in the Figure 3-2, these interfaces are described below and associated functional and performance requirements are included in this SRD.

Note: The context diagram in Figure 3-2 does not imply any particular architecture in the ship or airborne segment. It simply puts a context to the Input/Output (I/O) for the system that this specification defines.

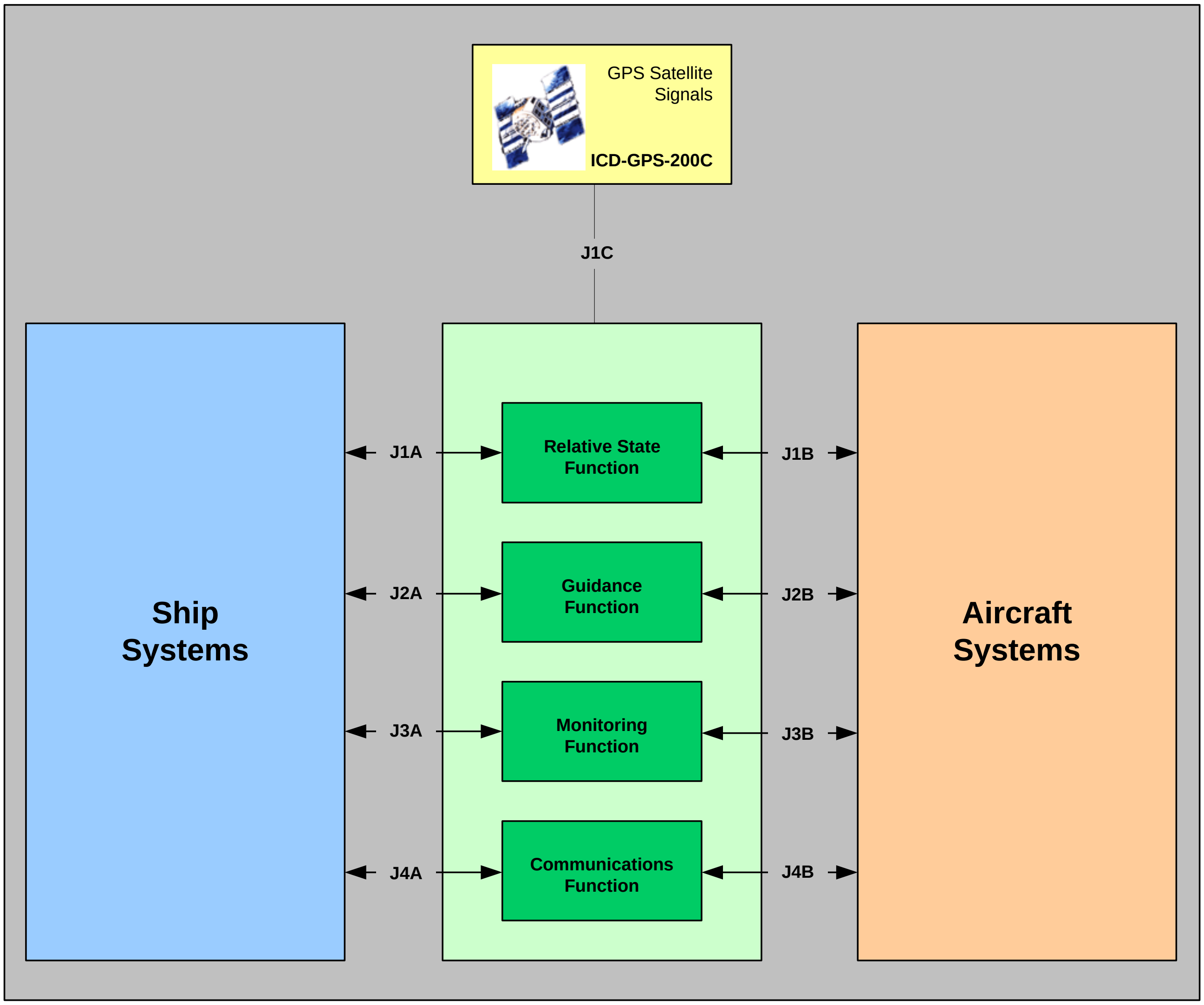

Figure 3-2: Sea Based JPALS External Interfaces

3.1.3.1 External Interfaces

3.1.3.1.1 Global Positioning System

Sea Based JPALS shall receive GPS ranging signals and navigation data on two frequencies, denoted L1 and L2, in accordance with ICD-GPS-200C [5].

3.1.3.1.2 Network Related Interfaces

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Sea Based JPALS requires a number of parameters to establish the DL network, including channel identification (ID), target ship ID, and ship ID. These may be internally generated by Sea Based JPALS functions or may be provided by external systems. External ship systems may provide a channel ID to the ship segment of Sea Based JPALS for the purposes of establishing a network. Similarly, the aircraft may identify a target ship ID or a channel ID for the DL to use for tuning and establishing a network connection. Sea Based JPALS also expects to receive (subscribe to) a ship ID from external ship systems that it provide (publish) to aircraft that join the network.

3.1.3.1.3 Status and Alerts

Sea Based JPALS, as a system, outputs status information for distribution to and use by other ship and aircraft systems.

3.1.3.1.4 Shipboard Interfaces

The Sea Based JPALS shipboard interfaces are described in Table 3-1. The data elements included in each data group listed in the table are defined in Section 6.

Table 3-1: Sea Based JPALS Shipboard External Interfaces

Interface Number	JPALS Function	Publishes	Subscribes To
J1A	Relative State		Ship Status Data
J2A	Guidance		Aircraft Geometry, Path Definition Data, Ship Geometry, Ship Wind Over Deck
J3A	Monitoring	Aircraft Approach Profile Changes, Aircraft Configuration, Aircraft ID, Aircraft Status, Guidance Data (deviation), Relative State Data	
J4A	Communications	Aircraft Maintenance Data, Air Traffic Management (ATM) Downlink Messages, J-UCAS Downlink Messages	ATM Broadcast Data, ATM Uplink Messages, Environmental Data, INS Alignment Data, J-UCAS Uplink Messages, Ship Wind Over Deck

3.1.3.1.5 Aircraft Interfaces

The Sea Based JPALS aircraft interfaces are described in Table 3-2. The data elements included in each data group listed in the table are defined in Section 6.

Table 3-2: Sea Based JPALS Aircraft External Interfaces

Interface Number	JPALS Function	Publishes	Subscribes To
J1B	Relative State	Absolute Aircraft State, Relative State Data, Ship Status Data	
J2B	Guidance	Guidance Data	Aircraft Approach Profile Changes, Aircraft Geometry, Aircraft Status, Path Definition Data

J3B	Monitoring	Aircraft ID, Aircraft Status, Relative State Data	Aircraft Configuration, Aircraft ID, Aircraft Status
J4B	Communications	ATM Broadcast Data, ATM Uplink Messages, Environmental Data, INS Alignment Data, J-UCAS Uplink Messages, Ship Wind Over Deck	Aircraft ID, Aircraft Maintenance Data, ATM Downlink Messages, J-UCAS Downlink Messages

3.1.3.2 Internal Interfaces

The Sea Based JPALS internal interfaces are shown in Figure 3-3 and described in Table 3-3.

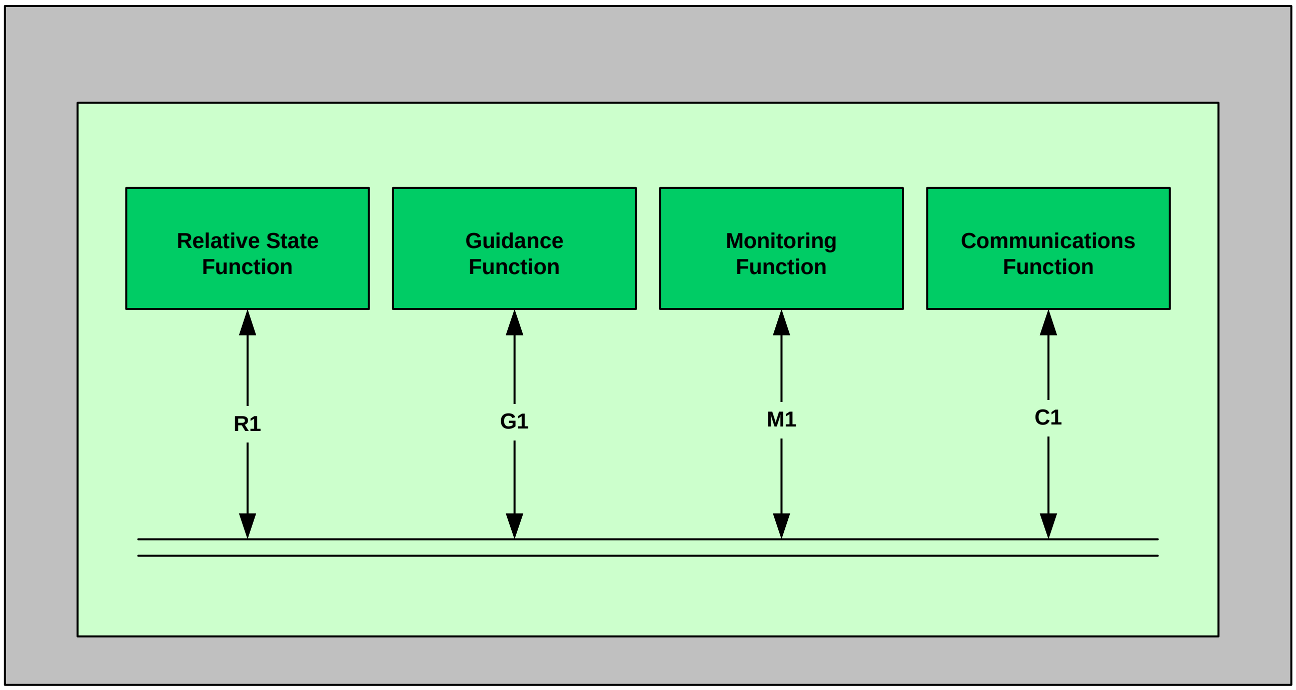

Figure 3-3: Sea Based JPALS Internal Interfaces

Table 3-3: Sea Based JPALS Internal Interfaces

Interface Number	JPALS Function	Publishes	Subscribes To
R1	Relative State	Relative State Data	
G1	Guidance	Aircraft Approach Profile Changes, Guidance Data	Relative State Data
M1	Monitoring		Aircraft Approach Profile Changes, Guidance Data, Relative State Data
C1	Communications		

3.2 Characteristics

3.2.1 Performance

3.2.1.1 General System Requirements

The requirements of this section apply to all Sea Based JPALS functions.

3.2.1.1.1 Probability of Detection, Classification, Location, and Exploitation

Sea Based JPALS shall operate while precluding a hostile force's ability to identify the presence of a signal and use that signal or the data in it to threaten the ship when the hostile force is located beyond the distance specified in the classified (TBR) document, .

Note: It is anticipated that this will be specified as a probability of detection (e.g., 5%) by an intercept receiver at a specified distance.

Per CJCSI 6130.01C [2], Sea Based JPALS shall encrypt any P(Y) code differential corrections.

Sea Based JPALS communications between air and ship shall employ communication security (COMSEC) and transmission security (TRANSEC).

3.2.1.1.2 Flying Qualities

The performance of manned aircraft systems using Sea Based JPALS will be rated as equivalent to or better than current systems using the Pilot Handling Qualities Ratings (HQR), which is based on the Cooper-Harper rating scale and pilot-induced oscillation (PIO) rating scale.

3.2.1.1.3 Data Link Network

3.2.1.1.3.1 Network Selection

Sea Based JPALS shall provide a means for the ship to select the Sea Based JPALS Channel.

Sea Based JPALS shall provide a means for the user aircraft to select the desired ship (or other Sea Based JPALS source).

3.2.1.1.3.2 Network Connectivity

Sea Based JPALS shall establish network connectivity (within the capacity limitations defined in this SRD) between Sea Based JPALS equipped platforms within the coverage volumes specified in this SRD.

Reception of a signal from the selected ship (within the coverage volumes specified in this SRD) shall be sufficient to establish a network connection.

Note: The acquisition of the DL network is determined by the reception of the data link signal from the ship. At this point the aircraft is part of the ship's DL network and begins to receive ship's location information. At the 200 nm threshold, this information will only be in a single direction and no transmissions take place from the aircraft to the ship.

Sea Based JPALS shall be capable of receiving the Channel ID or Target Ship ID to allow communication with a specific ship.

Sea Based JPALS shall output the Ship ID of the ship broadcasting on the selected Sea Based JPALS channel.

3.2.1.1.3.2.1 Acquisition Time

Within 50 nm region of the ship, an aircraft must make a request on the DL network to acquire a slot within the network and begin transmitting data back to the ship. This login request process shall be completed within TBR seconds.

Note: This assumes a network connection and is quantified as the amount of time from the initiation of a login request until an acknowledgment back to the aircraft that DL transmission may occur.

If the aircraft is on the deck of the ship prior to flight operations, it will initially receive the 200 nm DL content. The aircraft will initiate the login request in the same manner as done at the 50 nm threshold.

3.2.1.1.3.2.2 Reacquisition Time

There is no reacquistion time in the event of a loss of DL signal. Once an aircraft has had its login request processed, it is assigned a slot and will continue to use that slot even if a temporary loss of signal occurs. If, for example, the DL signal is not being received by the aircraft, the aircraft should continue DL transmission until the point after an aircraft completes deck operations on the ship.

3.2.1.1.3.2.3 Network Logoff

Sea Based JPALS shall include a mechanism to terminate individual network connections.

3.2.1.1.3.3 Network Medium

The Sea Based JPALS DL network shall utilize ultra-high frequency (UHF) spectrum.

The Sea Based JPALS DL channel shall have a bandwidth of 1.2 MHz.

All Sea Based JPALS communications between Sea Based JPALS capable platforms must comply with host nation frequency allocations.

3.2.1.1.3.4 Network Operational Constraints

The Sea Based JPALS DL network must be capable of operating in the presence of another Sea Based JPALS network (at a different frequency) without performance degradation.

3.2.1.1.4 Mission Initialization

Sea Based JPALS shall determine system suitability to support flight operations prior to launch, including predictive availability calculations for recovery.

3.2.1.1.5 Message Prioritization

Sea Based JPALS shall prioritize the processing of messages for transmission from both the ship and aircraft.

3.2.1.1.6 Interoperability

To achieve interoperability, Sea Based JPALS will comply with applicable information technology standards contained in the DoD Joint Technical Architecture (JTA) [6].

3.2.1.1.6.1 Geospatial Information and Services Support

Systems requiring geospatial information and services support shall be capable of accepting National Geospatial-Intelligence Agency (NGA) standard products.

Absolute position data shall be expressed in World Geodetic System 1984 (WGS-84) coordinates.

3.2.1.1.7 System Status

Sea Based JPALS shall output system operational status at least once every 2 seconds.

3.2.1.1.8 Test Support

Sea Based JPALS shall support test and qualification requirements for new aircraft/new ship installations.

Note: The Navy will be developing detailed requirements for this as the program and system development mature.

3.2.1.2 Navigation Requirements

Sea Based JPALS provides a navigation capability that supports operations defined in the CONOPS [3], including ship relative navigation, approach/marshal, landing, deck operations, NPA, precision approach (PA), waveoff, bolter, landing pattern, takeoff, and departure.

To support these operations Sea Based JPALS provides the functions and performance defined in the subsections below.

3.2.1.2.1 Performance Levels

Sea Based JPALS must meet certain performance requirements depending on the operation supported and the conditions under which that operation is performed. To facilitate the requirements identification process, distinct performance levels are defined to support various operations. These Sea Based JPALS

Performance Levels (SPL) are Relative Navigation (RN) 1-3, Precision Relative State (PRS), Precision Approach (PA), and Autoland (AL) as listed in Table 3-4. The table also indicates the typical operations that will be supported by each performance level and the unique outputs for that performance level. The performance required by each level is defined in various subsections of this document.

Note: A particular level of performance is a necessary but not sufficient condition for conducting the intended operation. The actual instrument approach minimums for a particular aircraft, at a particular ship, at a particular time, depend on other factors such as the availability of visual landing aids, aircraft and ship configuration, monitor downlink capability, crew qualifications, etc. The intent of organizing requirements by performance levels is to permit design and tailoring of the system to the needs of a particular ship and/or aircraft.

Table 3-4: Sea Based JPALS Operations and Performance Levels

Sea Based JPALS Performance Level (SPL)	Typical Operations Supported by Performance Level	Specified Navigation Output
RN 1 (Basic)	Relative navigation (outside 50 nm from ship)	Position, Velocity, Time (PVT), Deviations; Path error is assumed to be zero
RN 2 (Basic)	Marshal, Departure, Relative navigation (between 10 nm and 50 nm from ship)	PVT, Deviations; Path error is assumed to be zero
RN 3 (Basic)	Navigation within 10 nm from the ship; bolter pattern, departure, non-precision approach	PVT, Deviations; Path error is assumed to be zero
PRS (Precision)	Taxi (within 1 nm from the ship, including on the deck)	Position, Velocity, Acceleration, Tim (PVAT), Deviations, Path error is assumed to be zero
PA (Precision)	3-D approach guidance for use to within ¼ nm /100 ft of the ship; waveoff	Deviation States
AL (Precision)	3-D approach guidance to support autoland through bolter deck roll to departure from the angle deck	Deviation States

3.2.1.2.2 Relative State Function

The relative state function is a ship-relative positioning function that supports operations that can be performed at all performance levels. This function shall generate either a basic or a precision solution.

The basic position solution supports all relative navigation operations within 200 nm of the ship. This includes the following operations:

- Marshal
- Departure
- Basic Missed Approach and Bolter Pattern
- Non-precision Approach

The precision outputs support precision approach and landing operations to the ship, up to and including automatic landing capability in zero-ceiling, zero-visibility conditions. The precision solution supports the following capabilities:

- 3-D position determination for approach, landing, bolter, waveoff, and missed approach near the
- Automatic Takeoff guidance

- Automatic Taxi Support

3.2.1.2.2.1 Basic Relative State Functional Requirements

Within the coverage volume, Sea Based JPALS shall determine and output Position Data and Navigation State Data as defined in section 6.

Sea Based JPALS shall receive Ship Status Data as defined in section 6.

Sea Based JPALS shall output Ship Status Data, as defined in section 6, to the aircraft.

Sea Based JPALS shall continuously determine the performance level it is currently capable of supporting when performing operations requiring basic positioning.

Sea Based JPALS shall provide the capability to predict and output the availability of a performance level different than the current one when performing operations requiring basic positioning.

Sea Based JPALS shall determine and output Navigation Status Data as defined in section 6 when performing operations requiring basic positioning.

Sea Based JPALS shall receive NAVSTAR GPS signals in accordance with ICD-GPS-200C [5] when performing operations requiring basic positioning.

3.2.1.2.2.2 Precision Relative State Functional Requirements

Sea Based JPALS shall determine and output Position Data and Navigation State Data as defined in section 6 with respect to the selected ship when performing operations requiring precision positioning.

Sea Based JPALS shall receive Ship Status Data as defined in section 6.

Sea Based JPALS shall output Ship Status Data, as defined in section 6, to the aircraft.

Sea Based JPALS shall continuously determine the performance level it is currently capable of supporting when performing operations requiring precision positioning.

Sea Based JPALS shall provide the capability to predict and output the availability of a performance level different than the current one when performing operations requiring precision positioning.

If a Sea Based JPALS waveoff or bolter condition occurs during a precision approach, which is not caused by a failure of Sea Based JPALS, Sea Based JPALS shall provide the appropriate precision output to support the missed approach procedure.

If a Sea Based JPALS waveoff or bolter condition occurs during a precision approach, which is caused by a failure of Sea Based JPALS, Sea Based JPALS shall provide the user aircraft with relative navigation and guidance to support the missed approach procedure.

Note 1: Some failure conditions may render the Sea Based JPALS incapable of providing any navigation and guidance information to the aircraft. Others may allow for relative navigation and guidance to be given and in this case, the requirement applies.

Note 2: One potential cause of a waveoff may be due to the performance level not being sufficient to support the operation. In this case, Sea Based JPALS will determine the maximum performance level available and support what operations it can.

Sea Based JPALS shall determine and output Navigation Status Data as defined in section 6 when performing operations requiring precision positioning.

Sea Based JPALS shall receive NAVSTAR GPS signals in accordance with ICD-GPS-200C [5] when performing operations requiring precision positioning.

3.2.1.2.2.3 Basic Relative State Performance Requirements

3.2.1.2.2.3.1 Basic Relative State Coverage

Sea Based JPALS shall meet all basic requirements of the relative state function when the aircraft is within a 360 degree cylinder from the deck altitude to 60,000 feet operating height, has a clear line of sight to the ship and is within 200 nm from the ship.

3.2.1.2.2.3.2 Basic Relative State Capacity

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Sea Based JPALS shall be capable of providing the basic relative state function for all equipped aircraft in the coverage volume.

3.2.1.2.2.3.3 Basic Relative State Accuracy

The basic relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Position Accuracy (Navigation Sensor Error (NSE)) for RN 1 of 0.4 nm.

The basic relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Velocity Accuracy (NSE) for RN 1 of 10 m/s.

The basic relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Position Accuracy (NSE) for RN 2 of 262 m.

The basic relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Velocity Accuracy (NSE) for RN 2 of 3 m/s.

The basic relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Position Accuracy (NSE) for RN 3 of 48 m.

The basic relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Velocity Accuracy (NSE) for RN 3 of 1 m/s.

Note 1: The NSE is the magnitude of the vector between the relative vector provided by the system and the actual vector.

Note 2: This implies that the methods used for determining the position of the aircraft for this function must comply with the accuracy requirements of these SPLs.

Table 3-5: Summary of Basic Relative State Accuracy Requirements

SPL	Horizontal Position Accuracy	Horizontal Velocity Accuracy
RN 1	0.4 nm	10 m/s
RN 2	262 m	3 m/s
RN 3	48 m	1 m/s

3.2.1.2.2.3.4 Basic Relative State Integrity

The basic relative state function shall support the SIS integrity value of 2.4×10^{-6} per hour.

Note: Integrity is the probability that undetected hazardously misleading information (HMI) is generated by the system without timely warning. The integrity requirement is needed to ensure that the ship location function does not cause an aircraft to unknowlingly navigate to an undesirable location or state which could result in loss of the aircraft. The integrity requirement is also needed to ensure that the probability of undetected HMI is sufficiently low when the navigation solution is reported via the monitoring function and used for traffic separation.

3.2.1.2.2.3.5 Basic Relative State Continuity

The basic relative state function shall support the SIS continuity value of 9.6×10^{-4} per hour.

Note: The continuity of a system is the ability of the total system to perform its function without interruption once the intended operation has started. The continuity requirement is needed to control the rate of exception handling required by shipboard ATC/ATM personnel.

3.2.1.2.2.3.6 Basic Relative State Availability

The availability of the basic relative state function shall support the overall availability of at least 99.7% under non-jamming conditions.

Objective: The availability of the basic relative state function should support overall availability of at least 99.9% under non-jamming conditions.

Under jamming conditions defined in section 7, the availability value shall be at least 95%.

Objective: The availability of the basic relative state function should support the overall availability of at least 99% under the specified jamming scenarios.

Note 1: These requirements do not include avionics failures or the effects of scheduled shipboard segment maintenance or training which can be scheduled to avoid an impact on operations.

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Note 2: The 99.7% Ao matches current ATC system requirements. That Ao is achieved through the use of redundant systems.

Note 3: Non-jamming conditions are defined as electromagnetic interference typically seen in the shipboard environment. Additionally, the environment applies to all radio frequency (RF) signals necessary to provide this function at the specified level of performance.

3.2.1.2.2.4 Precision Relative State Performance Requirements

3.2.1.2.2.4.1 Precision Relative State Coverage

Sea Based JPALS shall meet the requirements of the precision relative state function when the aircraft is within a 360 degree cylinder from the deck altitude to 6,000 feet operating height, and is within 10 nm from the ship.

3.2.1.2.2.4.2 Precision Relative State Capacity

Sea Based JPALS shall be capable of providing precision relative state for any equipped aircraft in the coverage volume.

Note: This applies regardless of the operation for which the function is being used.

3.2.1.2.2.4.3 Precision Relative State Accuracy

The precision relative state function navigation accuracy shall support a 2 Sigma (95%) Vertical Position Accuracy (NSE) for PRS of 2 m.

The precision relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Position Accuracy (NSE) for PRS of 2 m.

The precision relative state function navigation accuracy shall support a 2 Sigma (95%) Vertical Velocity Accuracy (NSE) for PRS of 0.3 m/s.

The precision relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Velocity Accuracy (NSE) for PRS of 0.3 m/s.

The precision relative state function navigation accuracy shall support a 2 Sigma (95%) Vertical Acceleration Accuracy (NSE) for PRS of 0.15 m/s^2.

The precision relative state function navigation accuracy shall support a 2 Sigma (95%) Horizontal Acceleration Accuracy (NSE) for PRS of 0.15 m/s^2.

Note: This implies that the methods used for determining the position of the aircraft for this function must comply with the accuracy requirements of the SPLs.

Table 3-6: Summary of PRS Accuracy Requirements

State	Vertical Accuracy	Horizontal Accuracy
Position	2 m	2 m
Velocity	0.3 m/s	0.3 m/s
Acceleration	0.15 m/s^2	0.15 m/s^2

3.2.1.2.2.4.4 Precision Relative State Integrity

The probability that the precision relative state function provides position or observable data with errors exceeding the output protection level or not bounded by the uncertainty parameter for longer than a specified time-to-alarm without providing a warning is the probability of missed protection, denoted P(MP).

The precision relative state function shall support the SIS P(MP) value of 2.4 x 10^{-6} per hour.

This requirement assumes a single fault-free airborne subsystem supplying PVAT and related data to the airborne user.

The precision relative state function shall have a maximum time to alarm of 2 seconds.

The time to alarm requirement is defined to begin at the point in time at which a failure condition is of sufficient magnitude to cause the aircraft position error to exceed its alarm limit and end when the integrity warning is output.

Note: The time to alarm requirement is a system requirement to be allocated between ship and airborne segments.

3.2.1.2.2.4.5 Precision Relative State Continuity

The precision relative state function shall support the SIS continuity value of 9.6 x 10^{-4} per hour.

This requirement assumes a single fault-free airborne subsystem supplying PVAT and related data to the airborne user.

Note 1: The continuity of a system is the ability of the total system to perform its function without interruption once the intended operation has started. The continuity requirement is needed to control the rate of exception handling required by shipboard ATC/ATM personnel.

Note 2: The continuity requirement does not bound the overall continuity of the approach operation, which will depend on the particular aircraft integration. This continuity requirement does not protect against airborne configuration changes or failures in the airborne system, which is done through the aircraft certification process.

Note 3: A continuity restriction area exists within some time to go (for fixed wing operations) that is determined by the aircraft dynamic/maneuver limits, within which the system may generate alarms but not initiate a waveoff. The Sea Based JPALS must provide coasting through this region under conditions of a total loss of DL and airborne GPS measurements. Requirements for this type of operational response to DL and GPS failures are aircraft certification requirements and are not addressed in this document.

3.2.1.2.2.4.6 Precision Relative State Availability

The availability of the precision relative state function shall support the overall availability value of at least 99.7% under non-jamming conditions.

Objective: The availability of the precision relative state function should support overall availability of at least 99.9% under non-jamming conditions.

Under jamming conditions defined in section 7, the availability value shall be at least 95%.

Objective: The availability of the precision relative state function should support the overall availability of at least 99% under the specified jamming scenarios.

Note 1: These requirements do not include avionics failures or the effects of scheduled shipboard segment maintenance or training which can be scheduled to avoid an impact on operations.

Note 2: The 99.7% Ao matches current ATC system requirements. That Ao is achieved through the use of redundant systems.

Note 3: Non-jamming conditions are defined as electromagnetic interference typically seen in the shipboard environment. Additionally, the environment applies to all radio frequency (RF) signals necessary to provide this function at the specified level of performance.

3.2.1.3 Guidance Function

The guidance function computes guidance data required for area relative navigation and Case I, II, and III departures and recoveries, from marshal to approach, landing, waveoff, bolter, takeoff, and departure.

3.2.1.3.1 Guidance Functional Requirements

3.2.1.3.1.1 Stabilization Functional Requirements

For precision operations, Sea Based JPALS shall provide stabilized Path Deviation data as defined in section 6.

Sea Based JPALS stabilization performance will be at least equivalent to the current Automatic Carrier Landing System (ACLS) and be range based.

During final approach, the stabilized centerline shall be aligned with the landing area.

Sea Based JPALS shall support recovery operations during ship heading changes in the range of ± 0.5 deg/sec.

Sea Based JPALS shall utilize standardized stabilization across all ship types with respect to fixed wing, short takeoff vertical landing (STOVL), and vertical takeoff and landing (VTOL) aircraft with similar closure rates, respectively, to ensure consistent, repeatable, and predictable presentation to the aircrew.

3.2.1.3.1.1.1 Geometry Definition

Sea Based JPALS shall be capable of receiving ship specific survey measurements.

Sea Based JPALS shall be capable of receiving aircraft specific survey measurements.

Sea Based JPALS shall be capable of receiving a correction to the specified landing reference point (LRP) geometry.

Note: This correction will typically be in the form of a vertical bias based on certification of a specific aircraft on a specific ship.

Sea Based JPALS shall apply the ship and aircraft specific surveyed measurements to generate the correct path deviation data.

3.2.1.3.1.1.2 Deck Motion Compensation Data

Sea Based JPALS shall provide DMC Data as defined in section 6.

DMC shall compensate for ship's heave, sway, and surge motions.

The quality of the DMC data will be equivalent or better than the existing ACLS.

3.2.1.3.1.2 Path Determination Functional Requirements

3.2.1.3.1.2.1 Path Definition

Sea Based JPALS shall provide a means to obtain Path Definition data from the ship as defined in section 6.

Sea Based JPALS shall provide a means to obtain Path Definition data from the aircraft as defined in section 6.

Sea Based JPALS shall maintain Path Definition data, and allow for its update.

Sea Based JPALS shall support waypoint to waypoint entered legs.

Sea Based JPALS shall automatically update the path based on ship movement, including the base recovery course (BRC) or final bearing, as appropriate.

Sea Based JPALS shall compute the commanded path using the data from the path definition.

Sea Based JPALS shall transition each leg such that the commanded path acceleration does not exceed 5 g.

Sea Based JPALS shall transition the commanded path at tipover such that the commanded path acceleration does not exceed 1 g.

3.2.1.3.1.2.2 Centerline Angle Definition

Sea Based JPALS shall be capable of obtaining the centerline angle, which is specified relative to the keel. The centerline angle is the final approach angle.

For VTOL and STOVL operations, the aircrew shall be able to override the centerline angle assignment for guidance in emergency or special conditions.

If the centerline angle is overridden by the aircrew, the new centerline angle must be reported to the ship.

Sea Based JPALS shall not accept a change to the centerline angle while providing guidance relative to the centerline.

Note: These restrictions may be specified at a different distance for different types of aircraft.

3.2.1.3.1.2.3 Approach Path Definition

Sea Based JPALS shall provide a means to obtain glideslope angle information from the ship.

Sea Based JPALS shall provide a means to obtain glideslope angle information from the airborne platform.

If the glideslope angle chosen by the ship crew is overridden by the aircrew, the new glideslope must be reported to the ship.

Sea Based JPALS shall not accept a change to the glideslope angle while on glideslope or causing the computed tipover point to move aft of the aircraft current location.

Note: These restrictions may be specified at a different distance for different types of aircraft.

Fixed-wing approach operations to CV/CVN class ships shall use an approach path reference point defined from the fixed-wing TDP.

The approach path shall extend aft and upward at a glideslope angle from the set of {2.0 to 9.0} degrees in 0.25 degree increments.

STOVL and VTOL operations to all ship classes shall use an approach path reference point offset from the ship landing area in the ship body frame (x, y, and z offsets).

The course shall accommodate multiple segments/extensions with an angle selectable in 2 deg increments.

The vertical approach path to the approach path reference point shall accommodate multiple segments/extensions with a glideslope angle selectable from the set of {2.0 to 9.0} degrees in 0.5 degree increments.

3.2.1.3.1.2.4 Touchdown Point Definition

For VTOL and STOVL operations, Sea Based JPALS shall support the use of multiple TDP spots per ship.

The TDP to be used for landing shall be selectable by ID number (e.g., Spot 1, Spot 5, etc.).

Sea Based JPALS shall provide a means for the ship to select the desired TDP.

Note: TDP assignment will be based on standard operational procedures.

For VTOL and STOVL operations, the aircrew shall be able to override the TDP assignment for guidance in emergency or special conditions.

Sea Based JPALS shall not accept a change to the TDP selection while on glideslope or causing the computed tipover point to move aft of the aircraft current location.

Note: These restrictions may be specified at a different distance for different types of aircraft.

If the TDP chosen by the ship crew is overridden by the aircrew, the new TDP must be reported to the ship.

3.2.1.3.1.2.5 Guidance Output Data Generation

Sea Based JPALS guidance output shall compensate for movement and acceleration of the ship center of motion.

Sea Based JPALS guidance output shall compensate for the angular rate and acceleration of the BRC and final bearing.

Sea Based JPALS shall provide path range and velocity to the selected TDP for precision approach operations.

Sea Based JPALS shall provide path range and velocity to the path reference point for precision operations.

Sea Based JPALS shall transition from barometric altitude derived vertical guidance to Sea Based JPALS derived vertical guidance before tipover such that the commanded path acceleration does not exceed 1 g.

Sea Based JPALS shall output the commanded path.

For precision operations, Sea Based JPALS shall compute the commanded path rate and commanded path acceleration, using the data from the path definition.

Sea Based JPALS shall provide the position relative to the commanded path.

For precision operations, Sea Based JPALS shall provide the velocity and acceleration relative to the commanded path.

Sea Based JPALS shall provide the guidance protection level.

Sea Based JPALS shall provide the time of applicability (TOA) of its guidance outputs.

3.2.1.3.1.3 Alerts

Sea Based JPALS shall provide an indication that the system is unable to perform to the level necessary to complete the identified operation when the computed protection level exceeds the applicable alert limit.

Note 1: The appropriate alert limit will be based off ship class and type as well as aircraft type.

Note 2: Anytime the protection level exceeds the alert limit, Sea Based JPALS must output an alert; however, this does not require an alert to be displayed to the flight crew. Alerts to flight crew may be suppressed, as appropriate, based on operational and safety considerations.

3.2.1.3.2 Guidance Function Performance Requirements

3.2.1.3.2.1 Guidance Function Coverage

Sea Based JPALS shall meet the requirements of the guidance function when the aircraft is within a 360 degree cylinder from the deck altitude to 60,000 feet operating height, has a clear line of sight to the ship, and is within a maximum range of 200 nm from the ship.

3.2.1.3.2.2 Guidance Function Capacity

Sea Based JPALS shall be capable of providing guidance function outputs for all equipped aircraft in the coverage volume.

3.2.1.3.2.3 Guidance Function Accuracy

The accuracy requirements for the guidance function are defined in the following sub-sections.

Note: The method(s) used for determining the position of the aircraft for the guidance function must comply with the accuracy requirements of the SPLs.

3.2.1.3.2.3.1 Deviation Accuracy

The guidance function for the PA SPL shall support a vertical deviation accuracy of 2 meters when the aircraft distance from touchdown (DFT) is in the range -100 m to 1163 m.

The guidance function for the PA SPL shall support a vertical deviation accuracy of [2 + 2*(DFT-1163)/5816] meters where DFT is in the range 1163 m to 6979 m.

The guidance function for the PA SPL shall support a vertical deviation accuracy of 4 m where DFT is beyond 6979 m.

The guidance function for the PA SPL shall support a lateral deviation accuracy of 2 m when the aircraft DFT is in the range -100 m to 1163 m.

The guidance function for the PA SPL shall support a lateral deviation accuracy of [2 + 2*(DFT-1163)/5816] meters where DFT is in the range 1163 m to 6979 m.

The guidance function for the PA SPL shall support a lateral deviation accuracy of 4 m where DFT is beyond 6979 m.

The guidance function for the AL SPL shall support a vertical deviation accuracy of 0.4 m where DFT is in the range -100 m to 200 m.

The guidance function for the AL SPL shall support a vertical deviation accuracy of [0.4 + 3.6*(DFT-200)/6779] m where DFT is in the range 200 m to 6979 m.

The guidance function for the AL SPL shall support a vertical deviation accuracy of 4.0 m where DFT is beyond 6979 m.

The guidance function for the AL SPL shall support a lateral deviation accuracy of 0.4 m where DFT is in the range -100 m to 200 m.

The guidance function for the AL SPL shall support a lateral deviation accuracy of [0.4 + 3.6*(DFT-200)/6779] m where DFT is in the range 200 m to 6979 m.

The guidance function for the AL SPL shall support a lateral deviation accuracy of 4.0 m where DFT is beyond 6979 m.

Note 1: The guidance accuracy includes both NSE and path definition error (PDE).

Note 2: Even though guidance is output for RN 1-3 and PRS, the guidance accuracy and NSE are equivalent since it is assumed that the PDE is zero.

Table 3-7: Summary of Deviation Accuracy Requirements

SPL	DFT	Vertical Accuracy	Lateral Accuracy
PA	-100 m to 1163 m	2 m	2 m
	1163 m to 6979 m	[2 + 2*(DFT-1163)/5816] m	[2 + 2*(DFT-1163)/5816] m
	beyond 6979 m	4.0 m	4.0 m
AL	-100 m to 200 m	0.4 m	0.4 m
	200 m to 6979 m	[0.4 + 3.6*(DFT-200)/6779] m	[0.4 + 3.6*(DFT-200)/6779] m
	beyond 6979 m	4.0 m	4.0 m

3.2.1.3.2.3.2 Deviation Rate Accuracy

The guidance function for the PA SPL shall support a vertical deviation rate accuracy of 0.4 m/s.

The guidance function for the PA SPL shall support a lateral deviation rate accuracy of 0.4 m/s.

The guidance function for the AL SPL shall support a vertical deviation rate accuracy of 0.15 m/s.

The guidance function for the AL SPL shall support a lateral deviation rate accuracy of 0.15 m/s.

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Table 3-8: Summary of Deviation Rate Accuracy Requirements

SPL	Vertical Rate Accuracy	Lateral Rate Accuracy
PA	0.4 m/s	0.4 m/s
AL	0.15 m/s	0.15 m/s

3.2.1.3.2.3.3 Deviation Acceleration Accuracy

The guidance function for the PA SPL shall support a vertical deviation acceleration accuracy of 0.2 m/s^2

The guidance function for the PA SPL shall support a lateral deviation acceleration accuracy of 0.2 m/s^2.

The guidance function for the AL SPL shall support a vertical deviation acceleration accuracy of 0.075 m/s^2.

The guidance function for the AL SPL shall support a lateral deviation acceleration accuracy of 0.075 m/s^2.

Table 3-9: Summary of Deviation Acceleration Accuracy Requirements

SPL	Vertical Acceleration Accuracy	Lateral Acceleration Accuracy
PA	0.2 m/s^2	0.2 m/s^2
AL	0.075 m/s^2	0.075 m/s^2

3.2.1.3.2.4 Guidance Integrity

The probability that the guidance function provides deviation state data with errors exceeding the alert limit for longer than a specified time-to-alarm without providing a warning is denoted P(MP).

The guidance function shall support the SIS P(MP) value of 1.0 x 10^{-6} per approach.

The guidance function shall have a maximum time to alarm of 2 seconds.

Objective: The guidance function shall support the SIS P(MP) value of 1.0 x 10^{-7} per approach with a 1 second time to alarm.

Note: The per approach requirement is applied during precision approach. When guidance is provided for other operations, the per hour requirement from the positioning function will apply since the path data is assumed to be without error.

3.2.1.3.2.5 Guidance Continuity

The probability that the guidance function continues to provide deviation state data throughout the duration of the precision approach operation, once it is begun, is defined as continuity.

The Sea Based JPALS guidance function SIS shall support continuity per 15-second period of 8.0 x 10^{-6} for SPL PA.

The Sea Based JPALS guidance function SIS shall support continuity per 15-second period of 4.0 x 10^{-6} for SPL AL.

Note 1: The continuity of a system is the ability of the total system to perform its function without interruption during the intended operation. The continuity requirement is needed to control the rate of exception handling required of the Sea Based JPALS ATM functions.

Note 2: The per 15-second period requirement is applied during precision approach. When guidance is provided for other operations, the per hour requirement from the positioning function will apply since the path data is assumed to be without error.

3.2.1.3.2.6 Guidance Availability

The availability of the guidance function shall support the overall availability value of at least 99.7% under non-jamming conditions.

Objective: The availability of the guidance function should support overall availability of at least 99.9% under non-jamming conditions.

Under jamming conditions defined in section 7, the availability value shall be at least 95%.

Objective: The availability of the guidance function should support the overall availability of at least 99% under the specified jamming scenarios.

These requirements do not include avionics failures or the effects of scheduled shipboard segment maintenance or training which can be scheduled to avoid an impact on operations.

Note 1: The 99.7% Ao matches current ATC system requirements. That Ao is achieved through the use of redundant systems.

Note 2: Non-jamming conditions are defined as electromagnetic interference typically seen in the shipboard environment. Additionally, the environment applies to all RF signals necessary to provide this function at the specified level of performance.

3.2.1.4 Monitoring Function

The purpose of the monitoring function is to provide aircraft data to support situational awareness for both the aircraft operators and the ship controllers. The Sea Based JPALS monitoring function is comprised of two capabilities, namely basic and precision. The basic monitoring function will provide sufficient data to support departure, marshal, and approach controllers performing sequencing and separation. The basic monitoring function will also provide data from nearby aircraft for use by other aircraft systems to support improved pilot situational awareness. The Sea Based JPALS precision monitoring function will provide aircraft data for the final controller and LSO to monitor the approach.

3.2.1.4.1 Basic Monitoring Functional Requirements

Sea Based JPALS will output messages containing the information specified in the following sub-sections during all operations.

TOA shall be provided in all reports.

Note: The TOA of monitoring function reports indicates the time at which the reported values were valid.

3.2.1.4.1.1 Aircraft ID

The monitoring function shall provide the aircraft ID of the transmitting aircraft.

3.2.1.4.1.2 Relative State Data

Sea Based JPALS aircraft navigation state information will include the following elements:

1. Three-dimensional position
2. Three-dimensional velocity
3. Navigation Uncertainty

3.2.1.4.1.2.1 Position

Position information shall be transmitted in a form that can be translated, without loss of accuracy and integrity, to a relative latitude and longitude, barometric altitude, and relative height.

All position elements shall be referenced relative to the ship.

Both barometric pressure altitude and relative height shall be reported. Some applications may have to compensate if only one source is available.

Barometric pressure altitude shall be reported referenced to standard temperature and pressure.

Altitude shall be provided with a range of -1,000 ft up to 100,000 ft.

Note: It is planned that Sea Based JPALS will eventually also output absolute state vector components relative to the WGS-84 reference system for users outside the network. These will likely be transmitted simultaneously with and in the same message as the ship-relative vector components.

3.2.1.4.1.2.2 Velocity

The transmitting aircraft shall provide the following information:

1. Horizontal Velocity Vector
2. Altitude Rate

The monitor function geometric velocity information shall be referenced relative to the ship.

The horizontal velocity vector components are defined as the north-south and east-west velocity relative to the ship.

Reported ranges shall be [0-250] knots on the surface and [0-4000] knots airborne.

Altitude rate shall be designated as climbing or descending.

Altitude rate shall be reported up to 32,000 feet per minute (fpm). Barometric altitude rate is defined as the current rate of change of barometric altitude.

The relative altitude rate of the state vector is measured along the line from the ship to the current position of the aircraft. For NUC, values 8 and 9, relative altitude rates shall be reported.

For NUC values other than 8 and 9, barometric altitude rate or inertially augmented barometric altitude rate shall be reported.

3.2.1.4.1.2.3 Navigation Uncertainty

3.2.1.4.1.2.3.1 Position Uncertainty

The navigation uncertainty category (NUC) is reported so that controllers and LSO may determine whether the reported position has an acceptable level of integrity and accuracy for the intended use. A Horizontal Protection Level (HPL) must be computed dynamically by all receivers. The HPL is the primary basis for assigning the NUC. HPL is defined as "the radius of a circle in the horizontal plane (local plane tangent to the WGS-84 ellipsoid), with its center being at the true position, which describes the region which is assured to contain the indicated horizontal position."

Sea Based JPALS shall report the highest possible value for NUC based on the current HPL.

Sea Based JPALS shall report a NUC of 0 for an HPL greater than or equal to 1480 m or if the HPL is unknown or unavailable.

Sea Based JPALS shall report a NUC of 1 for an HPL less than 1480 m.

Sea Based JPALS shall report a NUC of 2 for an HPL less than 524 m.

Sea Based JPALS shall report a NUC of 3 for an HPL less than 240 m.

Sea Based JPALS shall report a NUC of 4 for an HPL less than 96 m.

Sea Based JPALS shall report a NUC of 5 for an HPL less than 60 m.

Sea Based JPALS shall report a NUC of 6 for an HPL less than 20 m.

Sea Based JPALS shall report a NUC of 7 for an HPL less than 8 m.

Sea Based JPALS shall report a NUC of 8 for an HPL less than 4 m.

Sea Based JPALS shall report a NUC of 9 for an HPL less than 2 m.

Sea Based JPALS shall report a NUC of 10 for an HPL less than 1 m.

Note 1: It is anticipated that these requirements will be revised to use both horizontal and vertical parameters to determine the NUC.

Note 2: The stringent probability of HPL shown above was derived assuming that a GPS integrity failure could affect all aircraft in the network at the same time.

Note 3: It is anticipated that these requirements will be revised to separately provide an integrity indication based on protection levels and an accuracy indication based on the estimate of position uncertainty (EPU).

3.2.1.4.1.2.3.2 Velocity Uncertainty

The Navigation Uncertainty Category Rate (NUCR) reflects the accuracy of the least accurate velocity component of the reporting aircraft's source of velocity data, and is denoted NUCR.

Sea Based JPALS shall report the highest possible value for NUCR based on the current Horizontal and Vertical Velocity Errors.

Sea Based JPALS shall report an NUCR of 0 when either the Horizontal Velocity Error (95%) is greater than or equal to 10 m/s or the Vertical Velocity Error (95%) is greater than or equal to 50 fps.

Sea Based JPALS shall report an NUCR of 1 when the Horizontal Velocity Error (95%) is less than 10 m/s and the Vertical Velocity Error (95%) is less than 50 fps.

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Sea Based JPALS shall report an NUCR of 2 when the Horizontal Velocity Error (95%) is less than 3 m/s and the Vertical Velocity Error (95%) is less than 15 fps.

Sea Based JPALS shall report an NUCR of 3 when the Horizontal Velocity Error (95%) is less than 1 m/s and the Vertical Velocity Error (95%) is less than 5 fps.

Sea Based JPALS shall report an NUCR of 4 when the Horizontal Velocity Error (95%) is less than 0.3 m/s and the Vertical Velocity Error (95%) is less than 1.5 fps.

Note 1: When an inertial navigation system is used as the source of velocity information, error in velocity with respect to WGS-84 is reflected in the NUCR.

Note 2: When any component of velocity is flagged as not available the value of NUCR will apply to the other components which are included in the report.

Note 3: Navigation sources, such as GPS and inertial, provide a direct measure of velocity which can be significantly better than that which could be obtained by position differences.

3.2.1.4.1.3 Aircraft Status Data

Sea Based JPALS shall provide the following aircraft status data:

1. Fuel State
2. Indicated Airspeed
3. Heading and Heading Rate
4. Malfunction and Priority Status
5 Expected Approach Time (EAT)
6. Ordnance Loadout Code

3.2.1.4.1.4 Aircraft Maintenance Data

Sea Based JPALS shall provide the aircraft's maintenance codes.

3.2.1.4.2 Precision Monitoring Functional Requirements

Sea Based JPALS will output messages containing the information specified in the following sub-sections when precision navigation data is available to the aircraft. The data defined below is in addition to the data sent as part of the basic monitoring function.

Sea Based JPALS shall automatically prioritize the aircraft coverage volume to allow service for the closest 10 aircraft on approach.

The operator shall be able to override the automatic priority or selection of aircraft.

3.2.1.4.2.1 Relative State Data

3.2.1.4.2.1.1 Position

All position elements shall be referenced relative to the ship.

Altitude shall be provided with a range of -1,000 ft up to 10,000 ft. When an aircraft is operating on the deck, the altitude is not required to be reported provided that the aircraft indicates that it is on the deck.

3.2.1.4.2.1.2 Acceleration

The transmitting aircraft shall provide the following information:

1. Horizontal acceleration vector
2. Altitude acceleration

The acceleration information shall be referenced relative to the ship.

The horizontal acceleration vector components are defined as the north-south and east-west acceleration relative to the ship. Reported ranges shall be [0-3] g on the surface and [0-10] g airborne.

Altitude acceleration shall be designated as climbing or descending.

Altitude acceleration shall be reported up to ± 1 g.

The altitude acceleration of the state vector is measured along the line from the origin of the ship to the current position of the aircraft.

3.2.1.4.2.1.3 Protection Levels

Sea Based JPALS shall provide the protection levels being used.

3.2.1.4.2.2 Guidance Data

Sea Based JPALS shall provide the deviation portion only of the Path Deviation data defined in section 6.

3.2.1.4.2.3 Aircraft Status Data

Sea Based JPALS shall provide the following aircraft status data:

1. True airspeed
2. Angle of Attack
3. Attitude Data
4. Engine Data
5. Estimated Gross Weight
6. Direct Lift Control Status

Note: This data is passed from external aircraft systems through Sea Based JPALS.

3.2.1.4.2.4 Aircraft Configuration Data

Sea Based JPALS shall provide the Aircraft Configuration Data defined in section 6.

3.2.1.4.2.5 Aircraft Approach Profile Changes

Sea Based JPALS shall provide changes made in the aircraft to the approach profile.

3.2.1.4.3 Basic Monitoring Performance Requirements

3.2.1.4.3.1 Basic Monitoring Coverage

3.2.1.4.3.1.1 Ship Coverage

Sea Based JPALS shall meet all requirements of the basic monitoring function when the aircraft is within a 360 degree cylinder from the deck altitude to 60,000 feet operating height, has a clear line of sight to the ship, and is within 50 nm of the ship.

Objective: With no emissions control (EMCON) restrictions in place, the ship coverage area should be extended to 90 nm.

3.2.1.4.3.1.2 Aircraft Coverage

Sea Based JPALS shall meet all requirements of the basic monitoring function when the receiving aircraft is within 15 nm of the transmitting aircraft and both aircraft are on the same Sea Based JPALS network.

Objective: Sea Based JPALS should meet the requirements of the basic monitoring function when both aircraft are within 20 nm of each other.

Objective: Sea Based JPALS should meet the requirements of the basic monitoring function when both aircraft are within range of each other and Sea Based JPALS is active. In other words, the aircraft should receive monitor data from other aircraft, regardless of whether the aircraft are sending monitor data to the same, or any, ship.

3.2.1.4.3.2 Basic Monitoring Capacity

3.2.1.4.3.2.1 Ship Capacity

Sea Based JPALS shall provide the basic monitoring function for at least 50 aircraft within the ship coverage region.

3.2.1.4.3.2.2 Aircraft Capacity

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Sea Based JPALS shall receive basic monitoring function information from all aircraft within the aircraft coverage volume.

3.2.1.4.3.3 Basic Monitoring Accuracy

Given the following definitions:

σ_{hp}: standard deviation of horizontal position error.

σ_{hv}: standard deviation of horizontal velocity error.

σ_{vp}: standard deviation of vertical position error.

σ_{vv}: standard deviation of vertical velocity error.

The basic monitoring function position output shall exhibit a σ_{hp} <= 20 m for 1 sigma, 1D.

The basic monitoring function position output shall exhibit a σ_{hv} <= 0.25 m/s for 1 sigma, 1D.

The basic monitoring function position output shall exhibit a σ_{vp} <= 30 ft for 1 sigma, 1D.

The basic monitoring function position output shall exhibit a σ_{vv} <= 1 fps for 1 sigma, 1D.

These limits are in order to assure satisfaction of basic monitoring function report accuracy.

The errors referred to in this section are specifically due to monitoring function quantization of state vector information and other effects.

3.2.1.4.3.4 Basic Monitoring Integrity

Basic monitoring function integrity is defined in terms of the probability of an undetected error in a report received by an application, given that the monitoring function report is supplied with correct source data. The integrity of the basic monitoring function data shall be 1×10^{-6} or better on a per report basis.

3.2.1.4.3.5 Basic Monitoring Continuity

The probability that the basic monitoring function report is unavailable during an operation, presuming that the system was available at the start of that operation, shall be no more than 2×10^{-4} per hour of flight.

Note: The allocation of this requirement to basic monitoring functions should take into account the use of redundant diverse implementations and known or potential failure conditions such as equipment outages and prolonged interference in the monitoring function broadcast channel.

3.2.1.4.3.6 Basic Monitoring Availability

The basic monitoring function shall support the overall availability value of at least 99.7%.

Objective: The availability of the basic monitoring function should be at least 99.9%.

Note: This requirement does not include avionics failures or the effects of scheduled shipboard segment maintenance or training which can be scheduled to avoid an impact on operations.

3.2.1.4.3.7 Monitoring Latency and Time Error Requirements

Delays exist between the measurement of aircraft position and velocity and the actual reporting of the information by the monitoring function. There are several sources of such delay or latency. Before the information reaches the monitoring function, delays occur both in the navigation system and in the data bus system that may be used to convey the information to the monitoring function. Within the monitoring function, delay can be caused by the computation time for preparing the transmission and for assembling the report. After the report leaves the monitoring function, additional delays may occur.

Delays that occur prior to the information reaching the monitoring function are not the subject of requirements in this SRD. Delays occurring after the information is reported by the monitoring function are likewise not considered in this SRD.

Compensation may be applied to the reported information in order to adjust, at least approximately, for the changes in aircraft state between the time of measurement and the time of the report. Compensation may be applied to position information while not being applied to velocity information. As a result, the two parts of a state vector may apply to two different times. This produces a velocity lag error if the reporting aircraft is accelerating.

3.2.1.4.3.7.1 Latency Definitions

Position latency is the difference, if any, between the TOA and the time the information is reported at the monitoring function output (the latter minus the former).

Velocity latency is defined in the same way, but will typically have a different value.

Note: While the position and velocity of an aircraft may be constantly changing, a particular measurement applies to the true state at a certain time. For cases in which compensation is not used, latency is the time difference between the time of measurement and the time it is reported at the monitoring function output (the latter minus the former). For cases in which compensation is used, the TOA of position and velocity will differ and the report contains the TOA of position. Latency includes the total time differences, whether it is constant with time or variable, and whether it is known by the application or uncertain.

Monitoring function latency is the component of latency attributable to the monitoring function.

Note: Typically the source will make measurements periodically, and will provide the information to the monitoring function once per period. If the monitoring function timing structure is independent of the source timing, as is typical, there will be a waiting time (a contribution to latency) between when the information is provided by the source and when it is transmitted. The average value of this asynchronization wait is one half the source period. This contribution to latency is attributed to the monitoring function. If a data bus is used to convey information from the source to the monitoring function it may contribute latency, but that contribution is not attributed to the monitoring function latency. Similarly, a data bus may be used to convey information from the monitoring function to an application and any resulting latency is not attributed to the monitoring function.

Report time error is defined as the reported time minus the true time of the measurement.

Note: Each monitoring function report includes timing information. The time in the report is taken to be the time of the position measurement. If the TOA of the position and velocity are different and are not reported separately, then the application can use the single reported time for both, with a resulting report time error.

Differential delay is the difference in adjacent aircraft report times used by a third party surveillance application.

Note: Differential delay, relative to the output of a separate surveillance system (e.g., radar), will also influence position registration error when the two outputs are combined.

3.2.1.4.3.7.2 Monitoring Latency Requirements

For NUC < 8, the monitoring function latency of the reported information shall be less than 1.2 s with 95% confidence.

For NUC >= 8, monitoring function latency shall be less than 0.4 s with 95% confidence.

The standard deviation of the report time error shall be less than 0.5 s (1 sigma).

The mean report time error for position shall not exceed 0.5 s.

The mean report time error for velocity shall not exceed 1.5 s.

Note: Differential delay errors should be considered and, if necessary, compensated for by the using application. The monitoring function is not required to compensate for differential delays; however, all necessary information to perform such compensation is included in the monitoring function state vector report.

3.2.1.4.4 Precision Monitoring Performance Requirements

3.2.1.4.4.1 Precision Monitoring Coverage

Sea Based JPALS shall meet the requirements of the precision monitoring function when the aircraft is within a 360 degree cylinder from the deck altitude to 6,000 feet operating height and is within 10 nm of the ship.

Objective: Sea Based JPALS shall meet the requirements of the precision monitoring function when the aircraft is within a 360 degree cylinder from the deck altitude to 10,000 feet AGL operating height and is within 10 nm of the ship.

3.2.1.4.4.2 Precision Monitoring Capacity

The precision monitoring function shall support a minimum of 10 aircraft within the service volume.

3.2.1.4.4.3 Precision Monitoring Acquisition Time

The time to return to normal operation (i.e., providing the service to the next available aircraft) shall be within 2 seconds.

3.2.1.4.4.4 Precision Monitoring Integrity

During an approach operation, the integrity of the precision monitoring function data shall be 1 x 10^{-6} per approach.

During operations other than approach, the integrity of the precision monitoring function data shall be 2.4 x 10^{-6} per hour.

3.2.1.4.4.5 Precision Monitoring Continuity

Continuity is determined by the overall effect a loss of the function would have on an aircraft being able to complete an approach once it had started. Lack of approach or LSO monitoring data may constitute a missed approach under instrument weather conditions.

The probability that the precision monitoring function report is unavailable during an approach operation, presuming that the system was available at the start of that operation, shall be no more than 4.0 x 10^{-6} per 15-second period.

The probability that the precision monitoring function report is unavailable during an operation other than approach, presuming that the system was available at the start of that operation, shall be no more than 9.6 x 10^{-4} per hour.

3.2.1.4.4.6 Precision Monitoring Availability

The precision monitoring function shall support the overall availability value of at least 99.7%.

Objective: The availability of the precision monitoring function should be at least 99.9%.

Note: This requirement does not include avionics failures or the effects of scheduled shipboard segment maintenance or training which can be scheduled to avoid an impact on operations.

3.2.1.5 Communications Function

The communications function allows for exchange of ATC data and commands between the pilot, unmanned vehicle, and the shipboard operators. It also provides for the exchange of aircraft reports during NATOPS operations and uplink of ships "99" information. It includes other configuration, initialization, and miscellaneous data exchange.

When a message is received, the communications function decodes the data units and determines the message urgency requirements. These requirements then direct the communications function concerning message handling. The communications function also provides the capability to code a message into data units for transmission. The specific requirements for the communications function are identified in the subsequent paragraphs.

3.2.1.5.1 Communications Functional Requirements

Sea Based JPALS shall notify the ship crew of any changes to the path definition data made onboard the aircraft, if the aircraft and modified path are within 50 nm.

Sea Based JPALS shall support automated routine aircraft transmissions from the aircraft to the Carrier Air Traffic Control Center (CATCC) or Amphibious Air Traffic Control Center (AATCC), LSO, and Pri-Fly.

Note: These will be defined as ATM Downlink Messages in the Sea Based JPALS DL SIS Interface Specification [13].

Sea Based JPALS shall support automated routine uplink of data messages, and downlink of verifications using non-voice techniques.

Note: The full set of data is defined in the CONOPS [3].

Sea Based JPALS shall support the capability to allow air traffic controllers, LSO, and the Air Boss to send air traffic commands to specific aircraft and receive aircraft response.

Note: These will be defined as ATM Uplink and Downlink Messages in the Sea Based JPALS DL SIS Interface Specification [13].

Sea Based JPALS shall provide the capability to deliver messages sent between the J-UCAS air vehicle and ship to the J-UCAS shipboard MCS.

Note: ATM Uplink Messages intended for the J-UCAS air vehicle must be simultaneously made available for the J-UCAS shipboard MCS. As such, it is anticipated that receipt of acknowledgments and responses may also be provided to the originating function by the MCS. It is not currently envisioned that Sea Based JPALS will support this function. The receipt of an acknowledgment or response (or lack thereof) from the J-UCAS air vehicle is an independent event from the transmission and receipt of corresponding messages over the Sea Based JPALS DL. The integration of the ATM function with Sea Based JPALS and the J-UCAS air vehicle and MCS will be discussed in the Ship Integration Guide.

Sea Based JPALS shall support transmissions between the J-UCAS air vehicle and the J-UCAS shipboard MCS.

Note: These will be defined as J-UCAS Uplink and Downlink Data Packets in the Sea Based JPALS DL SIS Interface Specification [13].

Sea Based JPALS shall output Aircraft Maintenance Data prior to shutdown.

Sea Based JPALS shall provide the capability to supply INS Alignment Data (defined in section 6) to the air vehicle inertial navigation system (INS) so it can accomplish an alignment while the air vehicle is on the flight deck.

The communications function message structure and coding shall minimize the potential for error resulting from coding ambiguity and support the predetermination of message processing and presentation requirements.

The communications function shall prioritize transmission of messages in accordance with the priority (i.e., routine, standard, priority, or immediate) assigned by the message-generating function.

3.2.1.5.2 Communications Performance Requirements

3.2.1.5.2.1 Communications Coverage

Sea Based JPALS shall meet all requirements of the communications function when the aircraft is within a 360 degree cylinder from the deck altitude to 60,000 feet operating height and the aircraft has a clear line of sight to the ship and is within 50 nm of the ship.

Objective: Without any EMCON restrictions in place, the service volume should extend to 90 nm.

3.2.1.5.2.2 Communications Capacity

Sea Based JPALS shall provide the communications function for up to 50 user aircraft within the coverage region.

3.2.1.5.2.3 Communications End-to-End Latency

The communications function must meet the following end-to-end latency requirements.

Routine message end-to-end latency shall be less than 15 seconds (TBR) 95% of the time.

Routine message end-to-end latency shall not exceed 30 seconds (TBR).

Standard message end-to-end latency shall be less than 5 seconds (TBR) 95% of the time.

Standard message end-to-end latency shall not exceed 10 seconds (TBR).

Priority message end-to-end latency shall be less than 1 second (TBR) 95% of the time.

Priority message end-to-end latency shall not exceed 2 seconds (TBR).

Immediate message end-to-end latency shall be less than 0.5 seconds (TBR) 95% of the time.

Immediate message end-to-end latency shall not exceed 1 second (TBR).

Note: Time starts upon message receipt by the communications function and concludes when the communications function outputs the message at the other end.

3.2.1.5.2.4 Communications Integrity

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The communications function integrity is defined in terms of the probability of an undetected error in a message displayed to a user. The integrity of the communications function shall be 1 x 10^{-6} (TBR) or better on a per message basis.

3.2.2 Physical Characteristics

3.2.2.1 Shipboard Compatibility

Sea Based JPALS shipboard equipment will not exceed the weight, size, or radar cross section of existing systems that perform precision approach and landing functions.

Sea Based JPALS shipboard equipment will not degrade the effectiveness of the ship's defensive systems, nor restrict flight deck handling and aircraft parking.

Sea Based JPALS shipboard characteristics and siting constraints will ensure operation is not significantly degraded by co-site interference**.**

3.2.2.2 Airborne Compatibility

Sea Based JPALS avionics shall not adversely impact aircraft requiring low observable performance.

Sea Based JPALS avionics will not exceed the weight and size of existing systems that perform Sea Based JPALS functions.

Sea Based JPALS avionics, including all required aircraft interfaces, must be electro-magnetically compatible with existing aircraft equipment.

Sea Based JPALS avionics must operate on existing aircraft power within existing aircraft power bus capacity.

Sea Based JPALS avionics must be capable of being interoperable with host aircraft interface requirements including analog systems, DoD Multiplex Data Bus and ARINC interfaces as applicable.

Sea Based JPALS airborne characteristics and siting constraints will ensure operation is not significantly degraded by co-site interference.

3.2.3 Reliability

System reliability is a measure of probability of failure free performance once called upon to perform.

The Mean Time Between Failures (MTBF) for the Sea Based JPALS shipboard system shall be at least 4,000 hours.

Objective: The MTBF should be at least 5,000 hours.

3.2.4 Maintainability

Maintainability is the measure of the ability of the Sea Based JPALS system to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources at the prescribed level of maintenance and repair.

Current planning requires maintenance to be performed at two levels, organizational and depot. Unique support equipment will be kept to a minimum.

All critical defined organizational level corrective and preventive maintenance functions should be capable of being performed on operating shipboard equipment without degrading the system below acceptable performance parameters.

Corrective and preventive interactive electronic maintenance procedures should be embedded within the system open architecture or linked, as needed, to the Built-In-Test prognostics and diagnostics capabilities of the system, as well as embedded virtual training.

Sea Based JPALS equipment will include an integrated hardware/software maintenance capability.

Corrective Maintenance Mean Time To Repair shall not exceed 2.0 hrs.

Objective: Corrective Maintenance Mean Time To Repair should not exceed 1.0 hrs.

Shipboard preventive or scheduled maintenance shall not exceed 2.0 hours per 30 days of operation.

Objective: Shipboard preventive or scheduled maintenance should not exceed 1.0 hour per 90 days of operation.

Periodic inspection requirements and preventive maintenance inspections will be designed to ensure system components are operational and/or prepared for deployment.

Operation and/or maintenance tasks on Sea Based JPALS equipment, including set-up/tear-down and pre-operational tasks shall be capable of being performed in full chemical warfare ensemble and/or cold weather gear.

3.2.5 Environmental

3.2.5.1 Ship Wind Over Deck

Sea Based JPALS must meet all requirements herein when operating within wind over deck values as specified for the platform.

Note 1: Nominal wind-over-deck values for fixed-wing aircraft operations are 0 to 40 kt with up to a 7 kt crosswind component.

Note 2: VTOL operations will typically encounter considerably larger crosswinds.

3.2.5.2 Ship Dynamics

Sea Based JPALS shall perform within the requirements of this specification when operated under conditions of ship's motion up to and including Sea State 5.

Objective: Sea Based JPALS should operate in conditions up to and including Sea State 6.

Note: Sea State is only one of several parameters that influence ship dynamics. Studies are currently being performed to further define this requirement.

System operation shall be possible outside these limits with a corresponding increase in touchdown dispersion or waveoff probability.

3.2.5.3 Aircraft Dynamics

The Sea Based JPALS shall meet the requirements of the basic relative state, guidance, basic monitoring, and communications functions when the aircraft is operating at speeds up to 550 knots true air speed (KTAS), at sustained coordinated turns of up to 60 deg angle of bank, at climb rates between ± 6,000 feet per minute, and at a maximum acceleration of ± 2 g (TBR).

The Sea Based JPALS shall meet the requirements of the precision relative state and precision monitor functions when the aircraft is operating at speeds up to 250 KTAS, at sustained coordinated turns of up to 30 deg angle of bank, at climb rates between ± 1800 feet per minute, and at a maximum acceleration of ± 2 g (TBR).

Note: Additional requirements will be included to bound the maximum expected jerk. An abnormal maneuver requirement will not be included.

3.2.5.4 GPS Signal Environment

The requirements of Section 3 shall be met under the conditions of interference, and intentional jamming and/or spoofing of the GPS signal as defined in section 7.

3.2.5.5 UHF Signal Environment

The requirements of Section 3 shall be met under the conditions of interference, and intentional jamming and/or spoofing of the ultra-high frequency (UHF) signals, as defined in section 7.

3.2.5.6 Natural Environment

3.2.5.6.1 Precipitation

Sea Based JPALS shall meet all requirements of this specification in the presence of precipitation in the amount of 16 mm/hr in a 5 nm wide rain cell without signal degradation below precision landing system parameters/minima.

Objective: Sea Based JPALS should meet all requirements of this specification in the presence of precipitation in the amount of 25 mm/hr in a 5 nm wide rain cell without signal degradation below precision landing system parameters/minima.

3.2.5.6.2 Biological/Chemical Contaminants

Sea Based JPALS shipboard equipment shall be able to withstand damaging environmental effects to include biological and chemical contamination and continue to provide reliable precision approach guidance information.

3.2.5.6.3 Fog

Sea Based JPALS shall meet all requirements of this specification in the presence of advection and radiation fogs without signal degradation below precision landing system parameters/minima.

3.2.5.6.4 Temperature

Sea Based JPALS shipboard equipment shall meet all requirements of this specification with the ship exposed to external temperatures in the range -51 degrees Celsius to +49 degrees Celsius..

Objective: Sea Based JPALS shipboard equipment should meet all requirements of this specification in the presence of external ship temperatures in the range -70 degrees Celsius to +60 degrees Celsius.

3.2.5.6.5 Wind

When operating, Sea Based JPALS shall meet all requirements of this specification in the presence of wind up to 75 knots.

Sea Based JPALS shall suffer no equipment damage in the presence of wind up to 101 knots.

3.2.5.6.6 Snow

Sea Based JPALS shall meet all requirements of this specification in the presence of the accumulation of up to 2 feet of snow without signal degradation.

3.2.5.6.7 Elevation

Sea Based JPALS shipboard equipment shall meet all requirements of this specification at elevations from -200 feet to +14,000 feet.

3.2.5.6.8 Ice and Hail

Sea Based JPALS shall meet all requirements of this specification in the presence of up to ½ inch accumulation of ice or ½ inch diameter size hail without damage or signal degradation.

3.2.5.6.9 Blowing Sand and Dust

Sea Based JPALS shall meet all requirements of this specification in the presence of sand concentration of 2.2 g/m^3 in 40 kt wind without damage or signal degradation below precision landing system parameters/minima.

3.2.5.6.10 Ship Conditions

In addition to these performance requirements, Sea Based JPALS must also physically survive the range of environmental conditions that ships are expected to encounter without experiencing significant physical damage.

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3.2.6 Transportability

Sea Based JPALS shipboard equipment is intended to be transported worldwide via rail, vehicle, helicopter lift, ship, and air. As such, Sea Based JPALS equipment should be designed for ground, sea, and air transportability. The equipment should be capable of being transported in both the vertical and horizontal attitude.

Sea Based JPALS shipboard equipment will have no unique handling requirements.

3.3 Design and Construction

3.3.1 Materials, Processes, and Parts

3.3.1.1 Design, Construction, and Workmanship

Sea Based JPALS equipment will conform to the applicable design criteria in MIL-HDBK-2036 [8] Appendix A.

Note: Detailed requirements from MIL-HDBK-2036 [8] will be levied in the Sea Based JPALS Shipboard System Performance Specification.

Mechanical components of the equipment shall be uniform in appearance and free from cross-threading, burrs, scratches, cracks, breaks, pits, dents, chips, sharp projections or edges, loose parts, and foreign material that may adversely affect equipment serviceability, performance, reliability, safety, endurance, or wear.

3.3.1.2 Design Assurance

Sea Based JPALS will be designed and developed so that the probability of providing misleading information and the probability of loss of function are acceptable based on the system integrity and continuity requirements, respectively. In order to demonstrate compliance, it will be necessary to conduct a safety assessment to evaluate the system implementation against known failure conditions.

Note: Unannunciated and unmitigated failure conditions of Sea Based JPALS that cause out-of-tolerance error conditions during any operation can be classified as severe/hazardous major. Failure conditions of Sea Based JPALS which cause an aborted approach, can be classified as severe/hazardous major.

3.3.1.2.1 Software Design Assurance

The software will be developed in a manner to support system integrity and continuity requirements.

Note: An acceptable means to demonstrate integrity and continuity compliance for Sea Based JPALS is to develop all software using established development processes that are compliant with known industry standards.

3.3.1.2.2 Hardware Design Assurance

The hardware will be developed in a manner to support system integrity and continuity requirements.

Note 1: An acceptable means to demonstrate integrity compliance for Sea Based JPALS is to show that no failure of the equipment can result in misleading information. This may be accomplished by designing the hardware in accordance with known industry standards.

Note 2: Demonstration of compliance with the continuity requirements depends on the required probability of a detected failure. The required probability will depend on the level of redundancy. Hardware design assessment must consider the MTBF of the equipment as well as the independence of failure modes for redundant equipment.

3.3.1.3 Product Marking

External and internal markings of shipboard equipment, assemblies, and component parts shall conform to the requirements of MIL-HDBK-454, Guideline 67 [7].

3.3.1.3.1 Radio Frequency Connectors and Receptacles

All RF connectors and receptacles furnished on the shipboard equipment for the purpose of making external connections shall be clearly identified by labels descriptive of their specific function.

Labels on connectors shall be located directly on the connector, on plates permanently attached to the connector, or on tabs or tapes attached to the connector.

Labels on receptacles shall be located directly on the receptacle, on the surface or panel immediately adjacent to the receptacle, or, if recessed, adjacent to the access opening.

3.3.2 Interchangeability / Modularity

Sea Based JPALS equipment shall meet the interchangeability and modularity requirements as specified by the host platform.

3.3.3 Safety

Equipment should be such that systems (including personnel, aircraft, other equipment, interfaces, and ordnance) will not be exposed to safety hazards during the installation, operation, maintenance, repair, or replacement of equipment or parts thereof.

Equipment should be such that systems will not be exposed to safety hazards should the equipment fail during the installation, operation, maintenance, repair, or replacement of equipment or parts thereof.

3.3.4 Human Factors

Guidelines for the design of the human factor aspects of controls, displays, and operating procedures are available in MIL-STD-1472 [9].

Design of controls, displays, symbology, and operating procedures will promote smooth, expeditious and error free system operation.

Controls and control arrangement shall be designed to minimize inadvertent actuation.

Controls shall not interfere with the access or actuation of other controls on the Sea Based JPALS equipment.

Controls must be accessible under all mission conditions in the manner intended by a user wearing required equipment and clothing. This includes the ability to use the controls in all required positions, combinations, and sequences.

System messages and displays presented to operators shall be appropriate and relevant to operators' activities and knowledge levels.

Except for use of pre-existing displays, any aircraft or ship visual display, readout, or operator message shall be compatible with the applicable night vision system.

User interface commands shall be designed to minimize operator performance errors and preclude operator errors on critical tasks through the use of error checking user validation, or other methods.

Visual and aural information must be usable by a user wearing required equipment and clothing.

Visual and aural displays must not inappropriately distract the user or interfere with the ability to use other displays or hear other aural signals.

All alpha-numeric, symbology, and other visual information must be legible and understandable as presented under all lighting, mission, and environmental conditions from the normal operating position.

Aural messages (verbal or otherwise) must be distinguishable and understandable under all flight and non-flight noise conditions from the normal operating position.

3.3.5 System Security

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In addition to the requirements in 3.2.1.1.1, Sea Based JPALS shall provide adequate safeguards and access control to protect critical information, parameters, and equipment.

3.3.6 Computer Resource Reserve Requirements

Sea Based JPALS equipment shall provide a minimum of 50 percent spare capacity for each type of computer memory for each computer processor.

Sea Based JPALS equipment shall provide a minimum of 50 percent spare processing and throughput capacity for each computer processor including input/output processing capacity.

If Sea Based JPALS functionality is hosted in other equipment, the host equipment must have sufficient memory, processing, and throughput to support the requirements of this specification in addition to the functions previously supported.

3.4 Logistics

3.4.1 Supportability

Supportability is that characteristic of the Sea Based JPALS design that provides for sustained system performance at a required readiness level when supported in accordance with specified concepts and procedures. Use of technology and design is highly favored to reduce supportability requirements.

Sea Based JPALS should rely primarily on BIT with minimal reliance on procedures and external support equipment except for existing general purpose electronic test equipment, if needed.

Sea Based JPALS shipboard equipment should incorporate embedded virtual training linked to maintenance tasks and BIT.

The Sea Based JPALS BIT prognostics and diagnostics shall permit the Condition Based Monitoring (CBM) of system critical attributes to accurately predict remaining useful life before failure, alarm detection and isolation, line replaceable unit (LRU) removal and replacement to avoid a critical failure, or actual removal of diagnosed faulty units.

Sea Based JPALS shall provide a remote CBM capability that supports remote monitoring of system status (i.e., from the CATCC, Tactical Air Control Center (TACC), or AATCC, Pri-Fly, or LSO station) and includes visual and audible alarms.

Note: This capability must be capable of being either installed at a remote location (e.g., CATCC) or integrated with a system already located at the remote location.

A maintenance and CBM capability shall be provided at the Sea Based JPALS equipment for fault detection, isolation, and correction.

Sea Based JPALS shall include a means of recording system condition and faults.

Sea Based JPALS shall also record all navigation, monitoring, and communication data sent from or received by the ship for incident, accident, and training purposes.

The fraction of faults detected (FFD) using continuous self-test shall be greater than 95%.

Objective: The FFD using continuous self-test should be greater than 98%.

100% of potential or actual critical alarms or failures shall be detected with a 95% repeatable confidence.

If Sea Based JPALS is a modification to an existing system, fault detection shall be in accordance with host system requirements.

95% of the failures detected shall be isolated to a single LRU using only BIT and continuous self-test.

If Sea Based JPALS is a modification to an existing system, fault isolation shall be in accordance with host system requirements.

If Sea Based JPALS is implemented as standalone avionics, less than 2% of all indicated faults shall be attributed to Sea Based JPALS avionics periodic BIT and self test false alarms.

If Sea Based JPALS is a modification to an existing system, false alarm rates shall be in accordance with host system requirements.

100% of actual or potential failures detected shall be isolated to a single LRU using BIT, self-test, Built In Test Equipment (BITE), and embedded maintenance procedures.

Organizational level maintenance shall utilize BITE to the maximum extent possible.

Organic depot support equipment shall be that type of automatic test equipment approved by the Service selected to be the source of repair.

The mean time between BIT false alarms for the shipboard equipment shall exceed 50,000 hours.

The system shall contain patch-free software with no unresolved mission critical problems.

Sea Based JPALS avionics shall be operable using existing aerospace ground handling equipment.

3.4.2 Operations and Support Affordability

System design will produce a 35% reduction in annual Operations and Support (O&S) cost per system over those incurred by systems it will replace.

Objective: It is desired that system design produce a 50% reduction in annual O&S cost per system over those incurred by systems it will replace.

3.5 Personnel and Training

Operation and maintenance of Sea Based JPALS will not require an increase to current service manpower authorizations or skill level requirements.

Objective: A decrease in operator and maintainer requirements will be sought.

3.5.1 Operational Personnel

The number of final controllers required to monitor/recover aircraft in the shipboard environment will not exceed 2 persons per shift.

Objective: The number of final controllers required to monitor/recover aircraft in the shipboard environment should not exceed 1 person per shift.

3.5.2 Maintenance Personnel

The total number of dedicated organizational level maintenance and logistics personnel needed to support Sea Based JPALS per shift will not exceed 1 person.

Objective: No dedicated organizational level maintenance and/or logistics personnel should be needed to support Sea Based JPALS per shift. Maintenance should be considered additional duties within planned maintenance workforce capability and capacity.

3.5.3 Training

No unique skills shall be required for the operation or maintenance of Sea Based JPALS.

3.6 Documentation

At a minimum, the following documentation will be developed for Sea Based JPALS:

- Test plans and reports for qualification, flight, and production tests and evaluation.
- Shipboard Installation and maintenance oriented documentation.

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4 Quality Assurance and Verification Requirements

This Section will define and describe the activities that ensure the system requirements are satisfied. It will ensure that the requirements of Section 3 are satisfied.

The following requirements will be included in this Section:

Responsibility for inspection-The assignment of the responsibility to perform inspections on delivered products, materials, and services to determine compliance with all specified requirements.

Special tests/examinations-Special tests and examinations required for sampling, qualification evaluation, or other tests and examinations, as necessary.

Requirements cross-reference-The correlation of each system requirement stated in Sections 3 to the quality assurance provisions specified in this Section.

4.1 Verification Strategy

4.1.1 Responsibilities

TBR

4.1.2 Special Tests and Examinations

4.1.2.1 Development Test

Development test activities shall be conducted to verify that the implemented hardware and software design meets the functional and performance requirements of this specification. Specific tests for verification are not conveyed, but normally include the verification of software and hardware requirements, stability and dry running, and system level testing.

4.1.2.2 Production Acceptance Test

Production Acceptance Test (PAT) shall be performed on each shipboard end-item before it leaves the factory to verify that the end-item conforms to applicable requirements, is free from manufacturing defects, and is substantially identical to the qualified system.

4.1.2.3 Site Acceptance Test

Site Acceptance Test (SAT) is conducted after completion of the shipboard hardware installation and the installation has been inspected and approved for workmanship and configuration. SAT is accomplished initially for the developmental system and is repeated for each production system after PAT. Testing shall be performed at each field site to verify that the new system is installed and operating properly on site.

4.2 Verification Methods

4.2.1 Inspection

Inspection is a method of verification to determine compliance with specification requirements and consists primarily of visual observations, mechanical measurements of the equipment, physical locations, and technical examination of engineering-support documentation.

4.2.2 Analysis

Analysis is a method of verification that consists of comparing hardware or software design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional and performance requirements. Analysis may also include the use of modeling and simulation.

4.2.3 Demonstration

Demonstration is a method of verification where qualitative versus quantitative validation of a requirement is made during a dynamic test of the equipment. Demonstration activities are further characterized by the following:

1. If a requirement is validated by test during first article qualification testing and the requirement has enough significance that it is re-tested during acceptance test, then this acceptance testing can be indicated in the matrix as a demonstration.

2. Software functional requirements are validated by demonstration since the functionality must be observed through secondary media.

4.2.4 Test

Test is a method of verification that will measure equipment performance under specific configuration-load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared with previous predicted success criteria, and evaluated to determine the degree of compliance.

4.2.5 Qualification by Similarity

Qualification by similarity consists of the review of certified/approved test data in conjunction with design evaluation data to substantiate the following:

1. A similar item of equipment has been previously qualified to the requirements of this specification, or a higher level.

2. The new item does not incorporate differences that would invalidate this criteria.

4.3 Requirements Traceability

Note: To be provided in a future revision (TBR).

5 Terms and Acronyms

5.1 Terms

The following terms are used throughout this document:

Term	Definition
Accuracy	The degree of conformance between the estimated or measured quantity and its true position and/or velocity.
Availability	The ability of the Sea Based JPALS system to perform its function at the initiation of the intended operation.
Base Recovery Course	The ship's magnetic heading during flight operations.
Cant Offset Angle	The difference between the final bearing and the base recovery course.
Continuity	The ability of the total system to perform its intended function without interruption during the intended operation.
Final Bearing	The magnetic bearing assigned by CATCC for final approach. It is an extension of the landing area centerline.
Cooper-Harper Rating	A uni-dimensional rating scale used to assess pilot workload qualities. It allows pilots to rate aircraft handling qualities on a numerical scale.
Integrity	Integrity is the assurance that all functions of a system perform within operational performance limits, and its ability to provide timely warnings to users when the system should not be used for navigation.
Latency	Latency, for cases in which compensation is not used, is the time difference between the time of measurement and the time it is reported at the function output (the latter minus the former). For cases in which compensation is used, latency is the difference between the time of applicability and the time the information is reported at the function output (the latter minus the former). Latency includes the total time differences, whether it is constant with time or variable, and whether it is known by the application or uncertain.
Marshal	A bearing, distance, and altitude fix designated by CATCC from which pilots will orient holding and from which initial approach will commence.
Navigation Sensor Error	Navigation Sensor Error that results from the residual composite errors from both the ground subsystem and airborne receiver after correcting the ranging source used to calculate deviations (The difference between the actual position of the airplane and the position fix provided by the navigation system).
Nautical Mile	A unit of distance used principally in navigation. The International Nautical Mile is 1,852 meters long.
Reliability	The probability that a system will operate within the specified tolerances.

5.2 Acronyms

The following abbreviations, acronyms, and mnemonics are used throughout this document:

Acronym	Description
AATC	Amphibious Air Traffic Control Center
ACLS	Automatic Carrier Landing System
ADMACS	Aviation Data Management and Control System
AGL	Above Ground Level
AL	Auto Land
ATC	Air Traffic Control
ATM	Air Traffic Management
BIT	Built-in-Test
BITE	Built-in-Test Equipment
BRC	Base Recovery Course
CATCC	Carrier Air Traffic Control Center
CBM	Condition Based Monitoring
CCA	Carrier Control Area
CDD	Capability Development Document
COMSEC	Communication Security
CONOPS	Concept of Operations
COTS	Commercial-Off-The-Shelf
CTOL	Conventional Takeoff and Landing
CV/CVN	Aircraft Carrier / Aircraft Carrier Nuclear
DA	Decision Altitude
DFS	Distance From Ship
DFT	Distance From Touchdown
DL	Data Link
DMC	Deck Motion Compensation
DoD	Department of Defense
EAT	Expected Approach Time
ECEF	Earth Centered, Earth Fixed
EMCON	Emissions Control
EPU	Estimate of Position Uncertainty
FFD	Fraction of Failures Detected
FPM	Feet Per Minute
GPS	Global Positioning System
HMI	Hazardously Misleading Information
HPL	Horizontal Protection Level
HQR	Handling Qualities Rating
ICD	Interface Control Document
ID	Identification
IFF	Identification Friend or Foe
IFLOLS	Improved Fresnel Lens Optical Landing System

ILARTS	Integrated Launce and Recovery Television System
INS	Interial Navigation Sensor
I/O	Input / Output
ISIS	Integrated Ship's Information System
JPALS	Joint Precision Approach and Landing System
JSF	Joint Strike Fighter
JTA	Joint Technical Architecture
J-UCAS	Joint Unmanned Combat Air System
KTAS	Knots True Airspeed
LSO	Landing Signal Officer
LRP	Landing Reference Point
LRU	Line Replaceable Unit
MCS	Mission Control Station
MTBF	Mean Time Between Failures
NATO	North Atlantic Treaty Organization
NATOPS	Naval Air Training and Operating Procedures Standardization
NAVSTAR	Navigation Satellite Timing and Ranging
NGA	National Geospatial-Intelligence Agency
NUC	Navigation Uncertainty Category
NUCR	Navigation Uncertainty Category Rate
NED	North, East, Down
NPA	Non-precision Approach
NSE	Navigation Sensor Error
O&S	Operations and Support
ORD	Operational Requirements Document
PA	Precision Approach
PAT	Production Acceptance Test
PDE	Path Definition Error
PHM	Predictive Health and Maintenance
PIM	Position and Intended Movement
PIO	Pilot-induced Oscillation
P(MP)	Probability of Missed Protection
PPS	Precise Positioning Service
PRS	Precision Relative State
Pri-Fly	Primary Flight Control
PVAT	Position, Velocity, Acceleration, Time
PVT	Position, Velocity, Time
RF	Radio Frequency
RN	Relative Navigation
SAT	Site Acceptance Test

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SATCC	Shipboard Air Traffic Control Communications
SIS	Signal-in-Space
SMS	Ship Motion Sensor
SOE	Shipboard Operating Environment
SPL	Sea Based JPALS Performance Level
SPS	Standard Positioning Service
SRD	System Requirements Document
STANAG	Standardization Agreement
STOVL	Short Takeoff Vertical Landing
TACAN	Tactical Air Navigation
TACC	Tactical Air Control Center
TD	Technology Development
TDP	Touchdown Point
TOA	Time of Applicability
TRANSEC	Transmission Security
TTG	Time-to-go
UAV	Unmanned Aerial Vehicle
UHF	Ultra-High Frequency
VTOL	Vertical Takeoff and Landing
WGS-84	World Geodetic System 1984
WOD	Wind Over Deck

6 Interface Data Definition

6.1 Absolute Aircraft State

Data	Input	Output	Definition
Position (ECEF) x, y, z coordinates		X	
Velocity (ECEF) x, y, z coordinates		X	
Acceleration (ECEF) x, y, z coordinates		X	

6.2 Aircraft Approach Profile Changes

Data	Input	Output	Definition
Approach/Centerline Angle	X	X	Changes made by the aircrew or unmanned aircraft to these approach profile parameters must be made available to the ship's personnel
Glideslope	X	X	
TDP	X	X	

6.3 Aircraft Configuration

Data	Input	Output	Definition
Autopilot Engage	X	X	
Flaps/Slats	X	X	
Hook Position	X	X	
Launch Bar Command and Status	X	X	
Landing Gear Position	X	X	
Parking Brake Engage	X	X	
Weight on Wheels	X	X	
Wing Fold	X	X	

6.4 Aircraft Geometry

Data	Input	Output	Definition
LRP Geometry	X		Defines LRP with respect to the aircraft GCP (e.g., GCP to Hook offset)
LRP Correction	X		Correction for LRP Geometry of specific aircraft at specific ship based on certification

6.5 Aircraft ID

Data	Input	Output	Definition
Tail Number	X	X	

6.6 Aircraft Maintenance Data

Data	Input	Output	Definition
PHM Data	X	X	Platform defined
Maintenance Codes	X	X	

6.7 Aircraft Status

Data	Input	Output	Definition
Air Data - Airspeed	X	X	
Air Data - Angle of Attack	X	X	
Air Data - Barometric Altimeter	X	X	
Attitude Data - Heading and Heading Rate	X	X	
Attitude Data - Pitch and Pitch Rate	X	X	
Attitude Data - Roll and Roll Rate	X	X	
Direct Lift Control Status	X	X	
EAT	X	X	
Malfunction and Priority Status	X	X	1=No malfunction / Not reported, 2 =Hydraulic, 3=Electric, 4=Fuel, 5 =Oxygen, 6=Engine, 7 =Communications, 8=NAVAIDS, 9 =Other
Engine Data - Autothrottle Engage	X	X	
Engine Data - Engine Speed	X	X	In percent
Engine Data - Engine Throttle Position	X	X	In percent
Engine Data - Jet Pipe Temperature	X	X	
Engine Data - Nozzle / Nacelle Position	X	X	
Estimated Weight	X	X	
Fuel State	X	X	
Ordnance Loadout Code	X	X	

6.8 ATM Broadcast Data

Data	Input	Output	Definition
ATM Broadcast Data	X	X	Defined in CONOPS [3]

6.9 ATM Downlink Messages

Data	Input	Output	Definition

ATM Downlink Messages	X	X	Defined in CONOPS [3]

6.10 ATM Uplink Messages

Data	Input	Output	Definition
ATM Uplink Messages	X	X	Defined in CONOPS [3]

6.11 Environmental Data

Data	Input	Output	Definition
Ceiling	X	X	
Relative Humidity	X	X	
Sea State	X	X	
Visibility	X	X	

6.12 GPS Space Segment

Data	Input	Output	Definition
GPS Ranging Signals and Navigation Data	X		Per ICD-GPS-200C

6.13 Guidance Data

Data	Input	Output	Definition
Bearing to Navigation Point		X	
Commanded Path		X	
DMC Data - TDP instantaneous position		X	All DMC measurements are relative to the average TDP in the vertical, longitudinal, and lateral directions (designated heave, surge, and sway).
DMC Data - TDP instantaneous velocity		X	
DMC Data - TDP instantaneous acceleration		X	
Guidance Protection Level		X	
Path Deviation Data - Deviation		X	Angular and rectilinear lateral deviations and angular and rectilinear vertical deviations from the defined path.
Path Deviation Data - Deviation Rate		X	Angular and rectilinear lateral deviation rate and angular and rectilinear vertical deviation rate from the defined path (precision operations only).

Path Deviation Data - Deviation Acceleration		X	Angular and rectilinear lateral deviation acceleration and angular and rectilinear vertical deviation acceleration from the defined path (precision operations only).
Range Along Commanded Path		X	
Range Rate Along Commanded Path		X	
TTG		X	
TOA		X	

6.14 INS Alignment Data

Data	Input	Output	Definition
East Velocity	X	X	Pass-through data from the Ship's INS for purposes of aligning the aircraft's INS that is available prior to departure from the ship.
East Acceleration	X	X	
Latitude and Longitude	X	X	
North Velocity	X	X	
North Acceleration	X	X	
Pitch, Pitch Rate, and Pitch Acceleration	X	X	
Roll, Roll Rate, and Roll Acceleration	X	X	
TOA	X	X	
True Heading	X	X	
Vertical Lever Arm	X	X	

6.15 J-UCAS Downlink Messages

Data	Input	Output	Definition
J-UCAS Downlink Messages	X	X	Vendor defined

6.16 J-UCAS Uplink Messages

Data	Input	Output	Definition
J-UCAS Uplink Messages	X	X	Vendor defined

6.17 Network Parameters

Data	Input	Output	Definition
Channel ID	X		Commanded communication frequency
Ship ID	X	X	ID of ship establishing network
Target Ship ID	X		Ship ID as input from aircraft for selecting desired network or channel

6.18 Path Definition Data

Data	Input	Output	Definition
Altitude	X		
Approach Angle / Centerline Angle	X		Horizontal path to offset approach reference point or TDP
Approach Type	X		
BRC	X		
Cant Offset Angle	X		
Decision Altitude (DA)	X		
Glideslope	X		
Leg Type	X		
Operation ID	X		Input that identifies the current operation to Sea Based JPALS
Speed	X		
TDP	X		
Waypoint Position	X		Defined in North, East, Down (NED) for ship relative and geodetic frame for absolute.
Waypoint Type	X		Relative or absolute

6.19 Relative State Data

Data	Input	Output	Definition
Navigation State Data - Position		X	Relative vector defined in NED between the ship reference point and the aircraft GPS antenna.
Navigation State Data - Velocity		X	
Navigation State Data - Acceleration		X	Precision Relative State output only.
Navigation Status - Decision Altitude Indication		X	Indication when the aircraft is at the DA for the assigned approach type (precision only).
Navigation Status - Protection Levels		X	Indication of the estimated error in the state information provided by Sea Based JPALS.
NUC		X	
NUCR		X	
Position Data - Magnetic Bearing to Ship		X	
Position Data - Range to Ship		X	Distance from aircraft reference point to ship reference point
TOA		X	

6.20 Ship Geometry

Data	Input	Output	Definition
Cant Offset Angle	X		
CM to GPS Geometry	X		
CM to SMS Geometry	X		
CM to TDP Geometry	X		

6.21 Ship Status Data

Data	Input	Output	Definition
Ship Magnetic Variation	X	X	
PIM	X	X	
PIM TOA	X	X	
Ship Position		X	Latitude and Longitude
Ship True Heading		X	

6.22 Ship Wind Over Deck

Data	Input	Output	Definition
WOD Direction	X	X	
WOD Magnitude	X	X	

6.23 Status and Alerts

Data	Input	Output	Definition
Status and Alerts		X	

7 Jamming Condition Definition

This section to be provided under separate cover at a later date.

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